AD A124 047 ENERGY MONITORING AND CONTROL SYSTEMS - FACTORY TEST PROCEDURES(U) KLING-LINDQUIST INC PHILADELPHIA PA J COSIOL ET AL. DEC 82 NCEL-CR-83 002 N62474-81-C-9379 1/2

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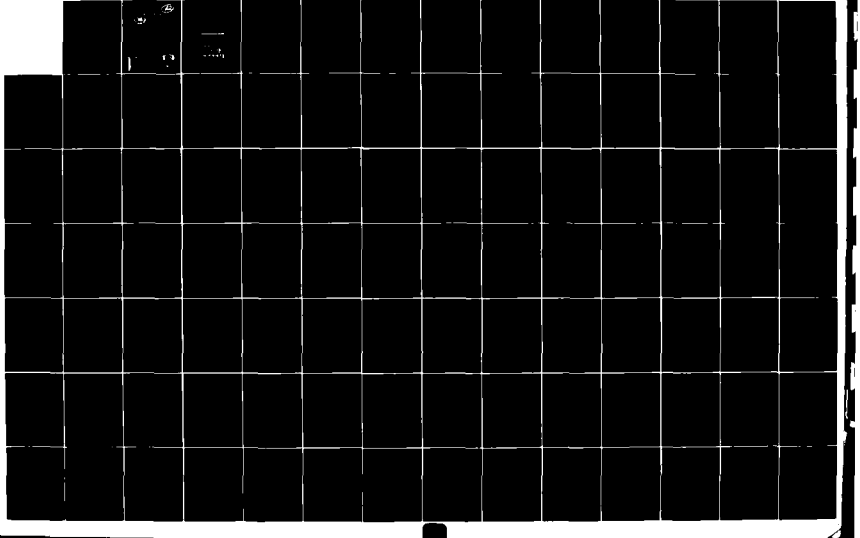

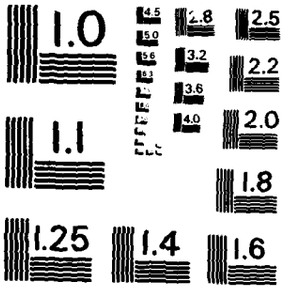

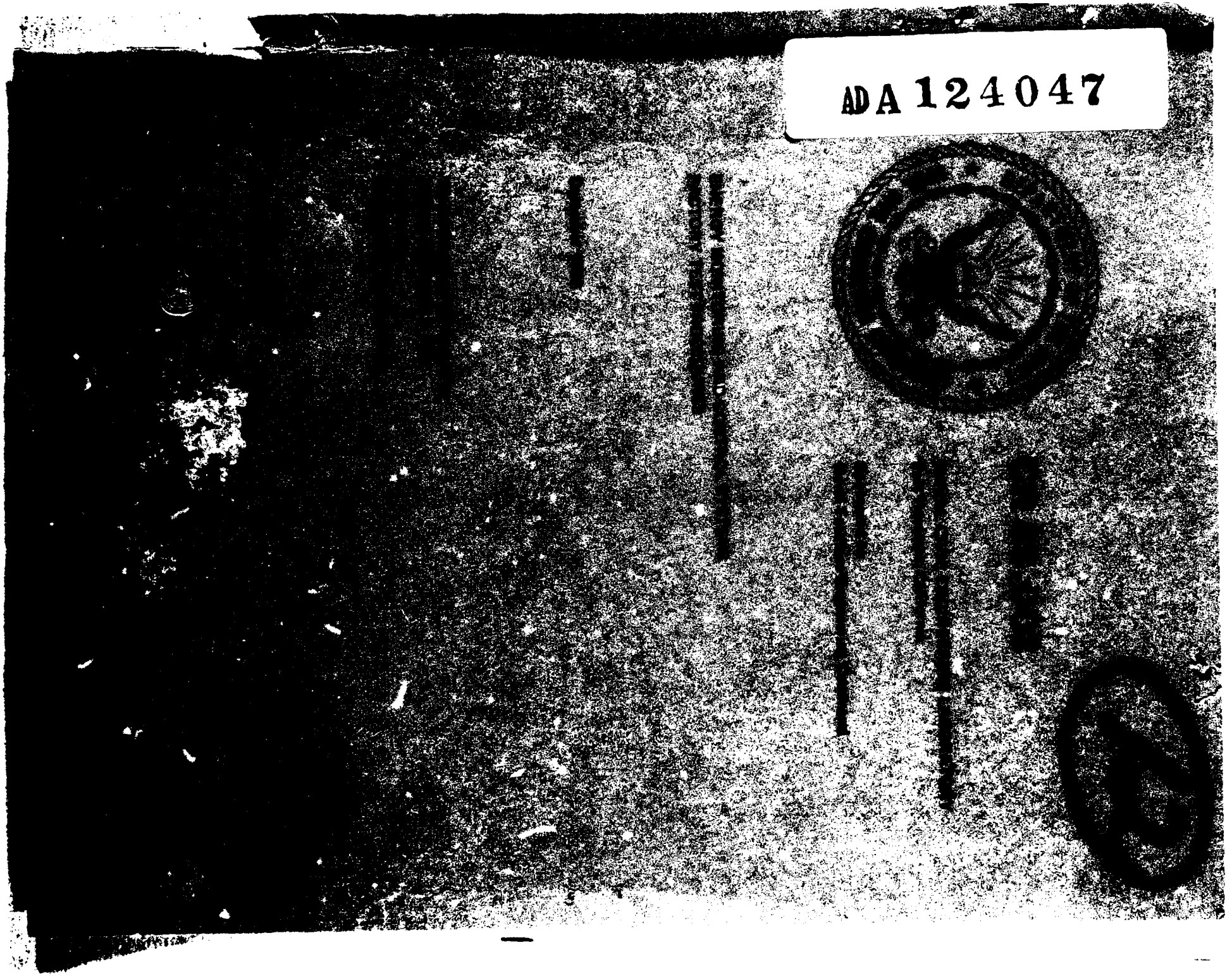

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20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents generic factory test procedures for EMCS. These test procedures are designed to demonstrate in the factory the technical, operational, and performance of an EMCS procured using the tri-service EMCS guide specifications.

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1.0 INTRODUCTION

This report presents generic Factory Test Procedures for Energy Monitoring and Control Systems (EMCS). These test procedures are designed to demonstrate that the technical, operational, and performance requirements called for by the June 1981, Tri-Service EMCS Guide Specifications are tested, and that definitive results are documented.

Table 1 on the following pages summarizes the Factory Test procedures applicable to each of four generic EMCS configurations (large, medium and small). Micro EMCS are not generally tested in the Factory.

Depending on the scope of work for the job under contract, some of the test procedures may not be applicable. The actual tests to be included for the contracted project must be based on the contract requirements, since they may differ from the June 1981 Tri-Service Specifications.

TABLE 1

FACTORY TEST REQUIREMENTS
FOR GENERIC EMCS CONFIGURATIONS

FACTORY TESTORY NUMBER	TEST TITLE	APPLIES TO MI	S	M	L
1	Initial System Equipment Verification	-	X	X	X
2	System Startup (Large/Medium/Small EMCS)	-	X	X	X
3	Power Line Surge Protection	-	X	X	X
4	Sensor and Control Wiring Surge Protection	-	X	X	X
5	Data Transmission Equipment Surge Protection	-	X	X	X
6	Data Communication Link Overvoltage Protection	-	X	X	X
7	Digital Input and Output Function Noise Protection	-	X	X	X
8	Analog Input Functions Noise Protection (Common Mode)	-	X	X	X
9	Analog Input Functions Noise Protection (Normal Mode)	-	X	X	X
10	CCU Software Validation	-	X	X	X
11	CCU Programmer Control Function	-	X	X	X
12	Operator Commands	-	X	X	X
13	Data Environment (DE) Definition Process	-	X	X	X
14	Reports - Fixed Format	-	X	X	X
15	Reports - Variable Format	-	-	X	X
16	Operator's Console Color Display (Large/Medium EMCS)	-	-	X	X
17	Operator's Console Display (Small EMCS)	-	X	-	-
18	Alarm Reporting	-	X	X	X
19	System Access Control	-	X	X	X
20	CCC Software Validation	-	-	-	X
21	CCC Programmer Control Function	-	-	-	X
22	FID Start up and Functions	-	X	X	X
23	FID Software Programming	-	X	X	X
24	Analog and Digital I/O Functions	-	X	X	X
25	Spare I/O Functions	-	X	X	X
26	FID RTC & RAM Battery Backup	-	X	X	X
27	FID/MUX/IMUX Battery Backup	-	X	X	X

NOTE: MI - Micro Configuration
S - Small Configuration
M - Medium Configuration
L - Large Configuration
X - Applicable
- - Not Applicable

TABLE 1

FACTORY TEST REQUIREMENTS
FOR GENERIC EMCS CONFIGURATIONS

FACTORY TEST NUMBER	TEST TITLE	APPLIES TO			
		MI	S	M	L
28	System Accuracy	-	X	X	X
29	System Reaction to Alarms	-	X	X	X
30	System Reaction to Commands	-	X	X	X
31	Disk Data Base Update	-	-	X	X
32	CCU Data Base Update	-	X	X	X
33	CCU Time Base Generator	-	X	X	X
34	CCC Time Base Generator	-	-	-	X
35	FID Real Time Clock	-	X	X	X
36	Command Priorities	-	X	X	X
37	Analog Commands	-	X	X	X
38	Alarms	-	X	X	X
39	Calculated Point	-	X	X	X
40	Analog Monitoring	-	X	X	X
41	Analog Totalization	-	X	X	X
42	Energy Totalization	-	X	X	X
43	Reports	-	X	X	X
44	Prediction Software	-	X	X	X
45	Time Programs	-	X	X	X
46	Event Programs	-	X	X	X
47	Extended Service Program	-	X	X	X
48	Schedule Start/Stop Program	-	X	X	X
49	Optimum Start/Stop Program	-	X	X	X
50	Duty Cycling Program	-	X	X	X
51	Demand Limiting Program	-	X	X	X
52	Day/Night Setback Program	-	X	X	X
53	Economizer Program	-	X	X	X
54	Enthalpy Program	-	X	X	X

NOTE: MI - Micro Configuration
S - Small Configuration
M - Medium Configuration
L - Large Configuration
X - Applicable
- - Not Applicable

TABLE 1

FACTORY TEST REQUIREMENTS
FOR GENERIC EMCS CONFIGURATIONS

FACTORY TEST NUMBER	TEST TITLE	APPLIES TO MI	S	M	X
55	Ventilation - Recirculation Program	-	X	X	X
56	Hot Deck-Cold Deck Temperature Reset Program	-	X	X	X
57	Reheat Coil Reset Program	-	X	X	X
58	Steam Boiler Optimization Programs	-	X	X	X
59	Hot Water Boiler Optimization Program	-	X	X	X
60	Hot Water OA Reset Program	-	X	X	X
61	Chiller Optimization Program	-	X	X	X
62	Chiller Water Temperature Reset Program	-	X	X	X
63	Condenser Water Temperature Reset Program	-	X	X	X
64	Chiller Demand Limit Program	-	X	X	X
65	Lighting Control Program	-	X	X	X
66	System Spare Memory Verification	-	X	X	X
67	Custom Programs	-	X	X	X
68	CCU Program Development	-	-	X	X
69	FID Software Programming	-	-	X	X
70	Algorithmic Control Sequences	-	X	X	X
71	Backup Mode for CCU Failure	-	-	-	X
72	Backup Mode for CCC Failure	-	-	-	X
73	Backup to Disk Storage System Failure	-	-	X	X
74	Printer Failure Mode	-	X	X	X
75	CRT Failure	-	X	X	X
76	FID Stand-Alone Mode	-	X	X	X
77	FID Stand-Alone Mode Demand Limiting Function	-	X	X	X
78	FID/MUX/IMUX Failure Mode	-	X	X	X
79	Error Detection and Retransmission (Large EMCS)	-	-	-	X
80	Error Detection and Retransmission (Med.& Small EMCS)	-	X	X	-
81	CLT and DTM Failure	-	X	X	X

NOTE: MI - Micro Configuration
S - Small Configuration
M - Medium Configuration
L - Large Configuration
X - Applicable
- - Not Applicable

TABLE 1

FACTORY TEST REQUIREMENTS
FOR GENERIC EMCS CONFIGURATIONS

FACTORY TEST NUMBER	TEST TITLE	APPLIES TO			
		MI	S	M	L
82	System Power Failure/Automatic Restart	-	X	X	X
83	CCU/CCC Diagnostics	-	X	X	X
84	FID PROM Programmer	-	X	X	X
85	FID Portable Diagnostic Devices	-	X	X	X
86	FID Test Set	-	-	X	X
87	Final System Equipment Verification	-	X	X	X

NOTE: MI - Micro Configuration
S - Small Configuration
M - Medium Configuration
L - Large Configuration
X - Applicable
- - Not Applicable

2.0 INITIAL CONDITIONS

2.1 General.

Factory Tests are the conducted under normal mode operation unless otherwise indicated in initial conditions of the test. System normal mode describes a condition in which the system is performing its assigned tasks in accordance with the contract requirements.

Factory Tests are conducted on EMCS hardware and software to be installed at the job site. Tests on data transmission media (DTM) should include at least one of each type of DTM to be used at the job site. Tests on FID°/MUX*/ IMUX operation should include at least one FID°/MUX*/IMUX in each DTM. Tests on I/O functions should include each type of I/O function to be installed in each DTM.

Micro EMCS require the use of a portable diagnostic programming, and bulk loading device for operator interface, for display and control of digital and analog points, and for display of memory locations. For large, medium, and small EMCS, these tasks are accomplished at the operator's console.

2.2 Contractor's Requirements.

Prior to the initiation of the tests, the contractor provides the approved Factory Test plans and procedures, plus sufficient documentation on the following to conduct the Factory Tests:

- EMCS hardware description.
- EMCS software description.
- Operator's commands.
- I/O summary tables with failure modes for test points.
- Required passwords for each operator access level.
- Description of each type of digital I/O and analog I/O to be used in the test.
- List of test equipment.

For each application program shown in the I/O summary table, the contractor provides:

- Inputs required for each program (I/O point values and status) and corresponding expected results for each set of input values.

*Large,Medium EMCS
°Large, Medium and Small EMCS

- Default values for the program inputs not implemented for the application programs to be tested.

- Failure modes for each I/O function to be tested.

2.3 Test Equipment and Set Up.

All test equipment is required to be traceable to NBS Standards or verified against a primary standard. The accuracy of the test equipment and overall test method must be at least twice the maximum accuracy required for the test. For example, if the temperature sensor has an accuracy of $\pm$ 1°F over the executed range, the test instrument used should have an accuracy greater than $\pm$ 0.5°F. All test equipment is provided by the contractor unless otherwise noted in the contract documents.

Test equipment for the Factory Tests includes the following:

- Data Environment Emulator.
- Surge Generator.
- 480 VAC RMS at 60 Hz. power source.
- 180 VAC peak at 60 Hz. power source.
- Noise generator - 5 Hz. steps at 1/3 scan rate of analog multiplexer.
- FID portable diagnostic programming and bulk loading device.
- FID test set.
- Equipment that can generate 10 dry contact closures per second and indicate the number of pulses transmitted.
- Equipment to test system accuracy - certified standard traceable to NBS. Accuracy should be at least twice the accuracy of the most accurate sensor to be tested.
- Stop watch with 0.1 second time intervals.
- White noise generator or communication error generator.

3.0 FACTORY TEST PROCEDURES

3.1 General.

This section presents the generic Factory Test procedures. Each test procedure contains the following:

- Test identification number
- Test title
- Objective
- Generic EMCS configuration to be tested (large, medium, small)
- Initial conditions (if applicable)
- Test equipment (if required)
- Sequence of events
- Expected results

A space has been left open for the project specification paragraph number since the project specifications will vary for each job. The label has been included as a reminder that each Factory Test should refer to appropriate project specification paragraph(s).

Some of the factory tests also contain some blank spaces which indicate that the information is to be obtained from the contract requirements for the contracted project. The blanks also highlight those requirements in the test procedures that the Government representative should verify against the contract requirements prior to the execution of the test. Other items in the test procedures are starred (*) to indicate the requirement may only be appropriate to specific EMCS size configurations. These items must also be verified by the Government representative in accordance with the contract requirements prior to the test.

TEST NO: Factory-1 Page 1 of 1
TITLE: Initial System Equipment Verification
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify that the hardware components of the system provided by the contractor are in accordance with the contract plans and specifications and all approved submittals.

INITIAL CONDITIONS

1. The contractor provides a list of approved system hardware components, including the name of the component, manufacturer, and model number. This list is based on the contract plans, specifications, change orders (if any) and approved submittals which must be available for reference purposes during the test.

EVENT	EXPECTED RESULTS
1. The model numbers of each hardware component should be examined and checked against the model numbers of the equipment provided by the contractor.	1. Model numbers of equipment provided must match the model numbers of the equipment on the approved submittals.

TEST NO: Factory-2 Page 1 of 1
TITLE: System Startup
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the system normal startup procedures can initiate EMCS operation including initializing CCU, CCC** and FIDS. To verify usable installed memory for non-EMCS tasks.

INITIAL CONDITIONS

1. All EMCS equipment is off.
2. The contractor provides non-EMCS task(s) to be loaded on system spare memory such that system spare memory is fully loaded throughout all factory tests.

EVENT	EXPECTED RESULTS
1. Energize the EMCS equipment (CCU, CCC*, FID/MUX*/ IMUXs, and peripherals.	1. EMCS equipment is ready for operation.
2. Initiate system startup using procedures (bootstrap) specified by the computer manufacturer.	2. System loads CCU, CCC** and FIDs with required software.
3. Load and run a non-EMCS task into system spare memory so that spare memory is fully loaded throughout the factory test.	3. Usable installed memory shall remain protected throughout the factory tests.
4. Load EMCS software.	4. System loads EMCS software.
5. At randomly selected times during the factory tests, request a status of the non-EMCS task.	5. At requested times, system displays status of tasks.

* Large/Medium EMCS
**large EMCS

TEST NO: Factory-3 Page 1 of 1
TITLE: Power Line Surge Protection
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that all equipment power supplies can withstand the power line surge test defined in MIL-STD-461B, Part 7, CS06.

INITIAL CONDITIONS

1. System power lines to each type of EMCS equipment to be installed are randomly selected for the test.

TEST EQUIPMENT

1. The test equipment shall generate the waveform described in MIL-STD-461B, Part 7, CS06 and Fig. 7-7.

EVENT	EXPECTED RESULTS
1. Connect the test equipment between each input line and ground for each piece of equipment to be tested, and apply the test waveform described in MIL-STD-461B, Part 7, CS06 and Fig. 7-7, while the EMCS is in operation.	1. After the application and removal of the test waveform, the tested equipment shall not exhibit any malfunctions, degradation of performance, or deviation from their normal mode of operation. Visually verify equipment operation by manually initiating changes in the DE that require the operation of the tested equipment. System displays required data.

TEST NO: Factory-4 Page 1 of 1
TITLE: Sensor and Control Wiring Surge Protection
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of all equipment to withstand surges induced in sensor and control wiring installed outdoors above ground by the test defined in IEEE Std-472.

INITIAL CONDITIONS

1. Power lines to each type of EMCS equipment to be installed are randomly selected for the test.

2. Surge protection is installed on circuits to be tested.

TEST EQUIPMENT

1. The test equipment shall generate the waveform described in IEEE Std-472.

EVENT	EXPECTED RESULTS
1. Connect the test equipment at the I/O function input terminals to be tested, and generate the test waveform described in IEEE Std-472, while the EMCS is in operation.	1. After the application and removal of the test waveform, the tested equipment shall not exhibit any malfunctions, degradation of performance, or deviation from its normal mode of operation. Visually verify equipment operation by manually initiating changes in the DE that require the operation of the tested equipment. System displays required data.

TEST NO: Factory-5 Page 1 of 1
TITLE: Data Transmission Equipment Surge Protection
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To test the ability of all contractor supplied communication equipment to withstand the test wave defined in IEEE Std-472.

TEST EQUIPMENT

1. The test equipment generates the waveform described in IEEE Std-472.
2. Disconnect the DTM and connect equipment to terminals.
3. Surge protection is installed on circuits to be tested.

EVENT	EXPECTED RESULTS
1. Connect the test equipment across each type of data transmission equipment to be used in the EMCS, and generate the test waveform described in IEEE Std-472, while the EMCS is in operation.	1. After the application and removal of the test waveform, the communication equipment shall not exhibit any malfunctions, degradation of performance, or deviation from its normal mode of operation. Visually verify equipment operation by manually initiating changes in the DE that require the operation of the tested equipment. System displays required data.

TEST NO: Factory-6 Page 1 of 1
TITLE: Data Communication Link Overvoltage Protection
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of all contractor supplied communication equipment to withstand a 480 VAC RMS 60 Hz signal superimposed on any data communication line terminal.

INITIAL CONDITIONS

1. Surge protection is installed on circuits to be tested.

TEST EQUIPMENT

1. The test equipment is a 480 VAC RMS 60 Hz single phase source.

EVENT	EXPECTED RESULTS
1. Connect the test equipment to each data communication equipment communication line terminal (one at a time) and apply the test voltage for a period of at least 1 minute while the EMCS is in operation.	1. After the application and removal of the test waveform, the communication equipment shall not exhibit any malfunctions, degradation of performance, or deviation from its normal mode of operation. Visually verify equipment operation by manually initiating changes in the DE that require the operation of the tested equipment. System displays required data.

TEST NO: Factory-7 Page 1 of 1
TITLE: Digital Input and Output Function Noise Protection
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the digital input and output function hardware to withstand noise on the control wiring connected to the digital input/output function hardware.

INITIAL CONDITIONS

1. At least one of each type of digital I/O function hardware to be installed is randomly selected for testing.

TEST EQUIPMENT

1. The test equipment is a 180 VAC peak 60 Hz single phase source.

EVENT	EXPECTED RESULTS
1. Command the system to display status of each selected digital I/O function.	1. Visually verify system display matches status of the I/O points in the DE.
2. Connect the test equipment across the digital input/output function hardware, and apply the test voltage for a period of at least one minute across the input of each type of digital input/output function hardware.	2. After the application of the test waveform, the digital input/output equipment shall not exhibit any malfunctions, degradation of performance, or deviation from its normal mode of operation.
3. Command the system to display status of each tested digital I/O function.	1. Visually verify system display matches status of the I/O points in the DE.
4. Change status of digital I/O function.	4. Visually verify operation of digital output function and display of digital input function with updated status.

TEST NO: Factory-8 Page 1 of 1
TITLE: Analog Input Function Noise Protection (Common Mode)
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the analog input hardware to withstand noise on the wiring connected the analog input. The common mode voltage appears as a voltage signal common to both inputs of a differential amplifier referenced to the signal common of the system. This test does not apply to single ended amplifiers.

INITIAL CONDITIONS

1. At least two of each type of analog input hardware to be installed is selected for testing.

TEST EQUIPMENT

1. AC Signal Generator.
2. DC Signal Source.

EVENT	EXPECTED RESULTS
1. Connect a DC Signal Source between the analog input and system ground. Adjust the source for 50 percent of full scale. Command the the system to display the values of each tested analog input.	1. Visually verify system display matches values of analog input in the DE.
2. Remove the ground connection from the DC Signal Source and connect an AC Signal between the point where the system ground was connected and system ground. Adjust the value of the AC voltage source to the maximum allowable common mode voltage. The AC signal frequency should be equal to the nominal power line frequency.	2. The rejection to the AC common mode signal should be at a DB level that is in accordance with the contract requirements.
3. Substitute a DC Signal Source for the AC Signal Source. Repeat 2. using DC Signal in lieu of AC Signal.	3. The rejection to the AC common mode signal should be at a DB level that is in accordance with the contract requirements.

***Large/Medium EMCS**

TEST NO: Factory-9 Page 1 of 1
TITLE: Analog Input Function Noise Protection (Normal Mode)
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the analog input hardware to withstand noise on the wiring connected to the analog input. The noise appears as an AC voltage in series with the signal source.

INITIAL CONDITIONS

1. At least two of each type of analog input hardware to be installed is selected for testing.

TEST EQUIPMENT

1. AC Signal Generator.
2. DC Signal Source.

EVENT	EXPECTED RESULTS
1. Connect a DC Signal Source between the input and system ground. Command the system to display values of each tested analog input.	1. Visually verify system display matches values of analog input in the DE.
2. Connect the DC Signal Source in series with the AC Signal Generator. Connect these sources between the analog input and signal ground. Turn on the generators and adjust the DC level for 50 percent of the maximum input signal value. Read the output with the AC signal at zero. Adjust the AC signal level so that the sum of the DC and peak AC values do not exceed the maximum allowable input signal amplitude. The AC signal frequency should be equal to the nominal power line frequency. Request display of tested analog signal and verify display against actual DE values.	2. The rejection to the AC signal should be at a DB level that is in accordance with the contract requirements.
3. Repeat Part 2 for a frequence range of 0-120 Hz.	3. The rejection to the AC signal should be at a DB level that is in accordance with the contract requirements.

*Large/Medium EMCS

TEST NO: Factory-10 Page 1 of 1
TITLE: CCU Software Validation
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the EMCS system contains all system software required in the contract documents to manage the CCU and associated peripherals as well as supporting command software and application programs.

INITAL CONDITIONS

1. The contractor provides a directory of disk files containing the CCU software required in the contract documents.

2. Written description of system software must be provided by the manufacturer of the CCU software. The system software description can be augmented by the EMCS manufacturers for those items that are EMCS specific.

EVENT	EXPECTED RESULTS
1. Command the system to display the directory of all files (name and size) containing CCU software.	1. System displays directory of the disk files. Name of the files and size must match the written description of the files required in each of the system programs specified in the contract documents.

TEST NO: Factory-11 Page 1 of 1
TITLE: CCU Programmer Control Function
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the CCU contains the required programmer control functions.

INITIAL CONDITIONS

1. The contractor provides a listing of location and contents of selected memory locations on the CCU.

2. The contractor provides a listing of CPU instructions to execute a set of tasks that can be visually verified.

EVENT	EXPECTED RESULTS
1. Command the system to load software required for EMCS operation.	1. System loads software.
2. Command the system to display contents of a specified main memory location.	2. System displays contents of designated main memory location. Visually verify that the display agrees with contractor supplied listing.
3. Command the system to execute the set of tasks, one at a time.	3. Visually verify tasks are executed in accordance with contractor supplied input.
4. Command the system to stop execution of tasks.	4. System execution is stopped.
5. Manually alter program execution counter and manually step through part of the program.	5. Program counter is altered.
6. Command the system to continue execution of tasks.	6. Visually verify tasks resume execution where directed by the program counter.

TEST NO: Factory-12 Page 1 of 6
TITLE: Operator Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which enables the operator to interface with the system for all functions associated with daily operation of the EMCS.

INITIAL CONDITIONS

1. The contractor must provide a list of Operator Commands and an explanation of the expected response to each command.
2. The DE contains disabled points not in communication with the System.
3. Operable points in the DE include one of each type of I/O points to be installed.
4. The contractor provides a listing of the I/O points to be addressed during the test.

SPECIAL COMMENTS

After entering an operator command, the system responds with a request for operator verification that the command is to be executed. In the following events which command the system to execute an operator command, it is assumed, in each case, the system will request operator verification and the operator will confirm the request prior to execution. It is assumed that the system will acknowledge command and commence processing within five seconds of command entry.

EVENT	EXPECTED RESULTS
1. Log on to the system with an incorrect password.	1. System does not allow the operator to log on, and indicates password is not valid.
2. Log on to the system with a password that allows total operator access to all operator commands.	2. System acknowledges log on.
3. Enter the operator command for the help function.	3. System displays all operator commands available to the operator at the password access level. The list must match the list of commands provided by the contractor.

TEST NO: Factory-12 Page 2 of 6
TITLE: Operator Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which enables the operator to interface with the system for all functions associated with daily operation of the EMCS.

EVENT	EXPECTED RESULTS
4. Enter the help command followed by a specific operator command.	4. System displays the purpose, use, and expected system reaction to the command. This explanation must agree with the contractor supplied documentation.
5. Command the system to display on hard copy.	5. System prints all succeeding operator inputs on the assigned printer.
6. Enter an abbreviated mode operator command.	6. Visually verify the system executes the command.
7. Enter an operator command without subsequent operator verification.	7. System requests operator verification.
8. Cancel the operator command.	8. Command is canceled.
9. Enter a command not listed in the set of operator commands.	9. System indicates command is invalid and does not request operator verification for execution.
10. Enter command for display of I/O functions defined in the data base, in accordance with the following address levels: . Area . Building . Unit . Point . Installation	10. System displays requested I/O function data on the selected output device.
11. Command the system to display status of selected digital points and analog points.	11. System commences display of data within 10 seconds from command entry.

TEST NO: Factory-12 Page 3 of 6
TITLE: Operator Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which enables the operator to interface with the system for all functions associated with daily operation of the EMCS.

EVENT	EXPECTED RESULTS
12. Command the system to shut down specified equipment at a designated FID/MUX*/IMUX.	12. Designated equipment commences shutdown at the specified location within 10 seconds from command entry.
13. Command the system to start up a device at a designated FID/MUX*/IMUX.	13. Designated equipment commences start up at the designated location within 10 seconds from command entry. System displays change in equipment status within 20 seconds from command entry. plus response time for the start up of controlled equipment.
14. Command the system to change the limits of a designated analog function. (For example, command a change in the high/low limit. Then change the DE condition to exceed the high or low analog set points.)	14. The system modifies the limit of each analog function within 10 seconds from command entry. Visually verify system displays analog point in alarm.
15. Command the system to adjust the set points of designated controllers.	15. Visually verify the system commences to adjust the set point of the designated controllers within 10 seconds of command entry. The system commences to display a change in point status within 20 seconds from command entry, plus response time for the adjustment of the controller and associated output.
16. Command the system to convert designated control functions from automatic mode (under program control) to manual control (from the operator's console).	16. Visually verify change in control mode from automatic to manual.
17. Command the system to initiate a change in the DE via the designated command function. (For example, command the system to shut down equipment.)	17. Visually verify the system commences to adjust the set point of the designated controllers within 10 seconds of command entry. The system commences to display a change in point status within 20 seconds from command entry, plus response time for the adjustment of the controller and associated output.

TEST NO: Factory-12 Page 4 of 6
TITLE: Operator Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which enables the operator to interface with the system for all functions associated with daily operation of the EMCS.

EVENT	EXPECTED RESULTS
18. Command the system to change equipment control modes currently in manual control to automatic control. Reset the time to initiate automatic control of equipment. (For example, reset the equipment software so that equipment will automatically shut down in five minutes.)	18. Visually verify change in control from manual to automatic mode.
19. Command the system to disable selected sensor inputs.	19. Visually verify specified inputs are disabled (in failure mode) within 10 seconds of command entry.
20. Command the system to address the disabled point identified in initial conditions.	20. System indicates command cannot be executed because the point is disabled.
21. Command the system to enable the points that were just disabled.	21. Visually verify each designated point is enabled (in normal mode) within 10 seconds from command entry.
22. Command the system to disable a designated FID.	22. Visually verify that the I/O functions of disabled FID are in the failure mode within 10 seconds from command entry.
23. Command the system to enable the disabled FID.	23. Visually verify the FID is enabled within 10 seconds from command entry. Visually verify change of status for the FID I/O functions to be the same as prior to disabling FID.
24. Command the system to disable the designated MUX*/IMUX panels.	24. Visually verify that the MUX*/IMUX I/O functions are in the failure mode within 10 seconds from command entry.

TEST NO: Factory-12 Page 5 of 6
TITLE: Operator Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which enables the operator to interface with the system for all functions associated with daily operation of the EMCS.

EVENT	EXPECTED RESULTS
25. Command the system to enable the disabled MUX*/IMUX	25. Visually verify each MUX*/IMUX is enabled within 10 seconds from command entry. Visually verify change of status for the MUX*/IMUX I/O functions to be the same as prior to disabling outputs within 10 seconds from command entry.
26. Command the system to change the status of a specified two mode point. (For example, command a change in status of a start-stop point from start to stop.)	26. Visually verify system executes change in status of the point within 10 seconds from command entry. System displays change of system or or device status within 20 seconds from command entry, plus response time for the start up of controlled equipment.
27. Command the system to change the status of a specified three mode point. (For example, change the status of a start-stop-auto point from start to stop.)	27. Visually verify system executes change of status of the point within 10 seconds from command entry. System displays change of system or device status within 20 seconds from command entry, plus response time for the start up of controlled equipment.
28. Command the system to execute task that is not appropriate for the type of point being identified. (For example, enter a START-STOP command on an analog point.)	28. System indicates the command cannot be executed because the command is not appropriate for the type of point.
29. Command the system to execute a task that contains a value outside the given point parameter definition.	29. System indicates that the command cannot be executed because the command parameter exceeds the range of the point.
30. Command the system to execute a task without providing sufficient information for execution.	30. System indicates that the command cannot be executed because there is insufficient information.

*Large/Medium EMCS

TEST NO: Factory-12 Page 6 of 6
TITLE: Operator Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which enables the operator to interface with the system for all functions associated with daily operation of the EMCS.

EVENT	EXPECTED RESULTS
31. Command the system to execute a task on an existing point that is currently not in communication with the system.	31. System indicates that the command cannot be executed because the point is currently not in communication with the system.
32. Command the system to execute a task on a non-existent point.	32. System indicates that the command cannot be executed because the point is non-existent.
33. Command the system to execute any operator commands displayed in response to the help command but not yet tested in the preceding events. Include any data necessary to execute the command.	33. System executes command and displays the requested change in the status of the point within 10 seconds from command entry. System displays change of system or device status within 20 seconds from command entry, plus response time for the start up of controlled equipment.
34. Log off the system.	34. System acknowledges log off.
35. Log on to the system with a password that allows minimum operator access to commands.	35. System acknowledges log on.
36. Enter a command that requires a higher level password for execution.	36. System indicates command cannot be executed at current operator access level.

TEST NO: Factory-13 Page 1 of 3
TITLE: Data Environment (DE) Definition Process
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify that point(s) in the data base can be defined by the operator from the operator's console with its own set of parameters, definitions and constraints.

INITIAL CONDITIONS

1. The contractor provides the necessary input data for an operator to define selected analog and digital point(s). The points selected for the test must include at least one of each type of I/O points to be installed, and at least one pulse accumulation point.

2. An allowed range of input has been assigned to each tested I/O point.

EVENT	EXPECTED RESULTS
1. Log on to the system with a password that allows operator access to the DE definition process.	1. System acknowledges log on.
2. Command the system to accept input for point definition.	2. System request inputs.
3. Input data for each point. . Name . Device or sensor type (i.e., sensor, control relay, motors) . Building and unit . FID number and channel . MUX*/IMUX number and channel address . Start time (each day) (digital functions only) . Stop time (each day) (digital functions only) . System status . kW (running) (digital kW demand function) . Range (analog functions only) . Span (analog functions only)	3. System acknowledges input for each point. At each step of the process inputs outside the predefined system ranges shall be rejected with a reason stated.

*Large/Medium EMCS

TEST NO:	Factory-13 Page 2 of 3	OBJECTIVE: To verify that point(s) in the data base can be defined by the operator from the operator's console with its own set of parameters, definitions and constraints.
TITLE:	Data Environment (DE) Definition Process	
APPLIES TO:	Large, Medium and Small EMCS	
REFERENCE:	Proj. Spec. Paragraph _____	

EVENT	EXPECTED RESULTS
3. (continued) . Engineering units conversion (scale factor) . Analog value in engineering units (analog functions only) . Low limit alarm (value in engineering units) (analog alarm functions only) . High limit alarm (value in engineering units) (analog alarm functions only) . Alarm class . Run time target (digital functions with run time targets) . Failure modes as specified in the I-O summary tables . Maximum starts (cycles) per hour (digital control functions only) . Minimum off time (digital control functions only) . Minimum on time (digital control functions only) . Maximum off time (digital control functions only) . High constraint limit (value in engineering units) (analog control functions only) . Low constraint limit (value in engineering units) (analog control functions only) . Other data required by the system as specified in the contract documents	
4. Command the system to modify at least one but not all previously entered data.	4. System requests input for modified values.
5. Command the system to display data for points.	5. Verify displayed data includes modified values.

TEST NO:	Factory-13 Page 3 of 3	OBJECTIVE: To verify that point(s) in the data base can be defined by the operator from the operator's console with its own set of parameters, definitions and constraints.
TITLE:	Data Environment (DE) Definition Process	
APPLIES TO:	Large, Medium and Small EMCS	
REFERENCE:	Proj. Spec. Paragraph _____	

EVENT	EXPECTED RESULTS
6. Command the system to schedule equipment operations that exceed the equipment constraints defined for each I/O control function in the test. . For example, for the digital control point, command the system to schedule: - More than the maximum allowed starts per hour - An off time that is shorter than the allowed minimum - An on time that is shorter than the allowed minimum . For example, for Analog control point, assign limits that exceed: - High Limit - Low Limit	6. System indicates that command cannot be executed because the equipment constraints have been exceeded.
7. Command the system to display the point definition of each point defined in the test.	7. Visually verify system display of data for each point in the test corresponds to initial input.

TEST NO: Factory-14 Page 1 of 2
TITLE: Reports (Fixed Format)
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software which generates the status reports and index reports in a fixed format either by operator request or in periodic automatic mode.

EVENT	EXPECTED RESULTS
1. Command the system to generate a status report of a list of equipment, sensors or control devices by each of the following categories: . Building . Zone . FID/MUX*/IMUX . Type	1. System displays status of equipment, sensors, or control devices in the selected category in a fixed format.
2. Command the system to generate an index report of the DE data base parameters, constraints and disposition.	2. Verify system display of the characteristics and disposition of points in the DE that corresponds with the data base.
3. Command the system to generate a status report automatically at fixed intervals. (For example, report on status of selected temperature sensors.)	3. System requests a time, the time interval between reports, and device on which report will be displayed.
. Enter desired time intervals. (At least four reports must be generated during the test period.)	. System acknowledges input.
. Specify the printer as the output device.	. Automatic report is generated at specified time(s) and displayed on the printer in fixed format.
. Command the system to cancel the report.	. System acknowledges command. Visually verify the periodic automatic report is not generated at the programmed time.
. Command the system to change the generation mode for a specified report - from periodic automatic to request mode.	. System acknowledges the change. Report that was formally periodic automatic will be generated as requested by the operator.

*Large/Medium EMCS

TEST NO: Factory-14 Page 2 of 2
TITLE: Reports (Fixed Format)
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software which generates the status reports and index reports in a fixed format either by operator request or in periodic automatic mode.

EVENT	EXPECTED RESULTS
3. (Continued)	
. Command the system to generate an immediate printout of the latest status report.	. System generates and displays the status report that was previously generated automatically.
4. Command the system to store the data from the latest status report.	4. Verify system stores data with a time tag.

TEST NO: Factory-15, Page 1 of 3
TITLE: Reports (Variable Format)
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software generating periodic automatic reports or reports by operator request in format designated by operator using any item in the data base.

INITIAL CONDITIONS

1. The DE is set up to generate at least ____ alarm conditions. Each alarm must have correlated dependent parameters. (For example, a start/stop alarm on a fan would also result in temperature alarms.) At least one alarm must have ____ dependent parameters.

2. The DE must provide the necessary input data to the system for the required reports to be generated.

3. The contractor must indicate how much storage is allocated for each type of report and relate this value to the size and quantity of profile reports required by the contract documents.

EVENT	EXPECTED RESULTS
1. Command the system to generate a system status report. Enter format and data on equipment, sensors, or control devices to be included in the status report. Request that the status of equipment or parameters be given by each of the following categories: . Building . Zone . FID . Type Specify output device to be CRT.	1. System requests report data, format and the output device. System acknowledges input. System displays status report on CRT.
2. Command the system to generate an index report. (For example, request an index report on all points that are "on".) Specify format and data requirements for the report. Specify output device to be CRT.	2. System requests report data, format and the output device. System acknowledges input, generates, and displays the index report. Verify displayed output corresponds to expected results.

TEST NO: Factory-15, Page 2 of 3
TITLE: Reports (Variable Format)
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software generating periodic automatic reports or reports by operator request in format designated by operator using any item in the data base.

EVENT	EXPECTED RESULTS
3. Command the system to generate a correlated alarm report. Specify format and data requirements, which must at least include: . Identification of the initiating alarm . Identification of correlated dependent parameters. . Status of each dependent parameter when the alarm condition is detected on the initiating point. Specify CRT to be ouput device.	3. System requests report data, format, and output device. System acknowledges input. System generates and displays the requested alarm report on the CRT.
4. Command the system to generate a profile report. (For example - kilowatt hours vs. time, or kW demand vs. outside air). Specify format and data requirements for profile reports. Specify at least one profile report to contain the maximum number of samples: Report data requests may include such profiles as the following: . Power consumption (value vs time). . Power demand (value vs time). . Temperatures (value vs time). . Equipment subsystem profiles (value vs value, value vs time).	4. System requests report data, format and output device. System also requests time interval between reports. System acknowledges input.

TEST NO: Factory-15, Page 3 of 3
TITLE: Reports (Variable Format)
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software generating periodic automatic reports or reports by operator request in format designated by operator using any item in the data base.

EVENT	EXPECTED RESULTS
4. (continued)	
Specify report time interval to such that for each of the ____ reports the ____ most recent values are generated every ____ minute.	System acknowledges input.
Specify output device to be the printer.	System generates and displays profile reports on the printer.
5. Command the system to display the storage space allocated for each report.	5. Verify that sufficient storage space is allocated on disk to store the _____ profiles of _____ samples each in accordance with the contractor's method of storing input parameters.
6. Command the system to terminate the profile reports.	6. System terminates profile report generation.
7. Command the system to generate a status report automatically at fixed time intervals. (For example, report on all points that went into an alarm condition within the last hour.)	7. System requests a report data and format, a report time, the time interval between reports and device on which report will be displayed.
Enter desired time intervals so that at least four reports are generated during the test period.	System acknowledges input and generates at least four reports during the test period.

TEST NO: Factory-16 Page 1 of 5
TITLE: Operator's Console Color Display
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that operates the operator's console and generates graphic displays.

INITIAL CONDITIONS

1. The contractor provides an I/O summary of the DE list associated with each graphic display requested during the test.
2. The DE is set up to generate an event (such as an alarm) to test the software for displaying a graphic after a specified event.
3. The contractor provides a sample new graphic to be developed during the test.
4. The contractor provides a list of standard graphic symbols required in the contract documents, plus some additional graphic symbols to be added to the system during the test.

EVENT	EXPECTED RESULTS
ALPHANUMERIC DISPLAY	
1. Enter operator password to access the highest operator level.	1. System acknowledges password.
2. Command the system to generate an alphanumeric CRT display of I/O functions by system or individual I/O points. (For example, request a CRT display of an air handling unit.)	2. Visually verify that the system displays the following data in fixed format: . Time of day (first field) . Day of week (first field) . Two analog functions (first field) . Operator name (first field) . Alarm display and operator interaction (second field) System displays in fixed format; the requested data. (third field)
3. Command the system to list the graphic displays in the system.	3. System displays a list of graphic displays available to the operator. Verify list corresponds to contract documents.

TEST NO: Factory-16 Page 2 of 5
TITLE: Operator's Console Color Display
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that operates the operator's console and generates graphic displays.

EVENT	EXPECTED RESULTS
GRAPHIC DISPLAY	
4. Command the system to display a graphic from the the prior list generated by the system.	4. Operator console displays fixed format information plus graphic display with associated live data.
5. Command the system to display all standard graphic symbols in the system library.	5. Visually verify the system displays all symbols required in the contract documents. These symbols conform to the ASHRAE Handbook of Fundamentals and include: . Pump: Right hand (RH), Left Hand (LH), upflow (U), Downflow (D). . Valve, three way: Horizontal (H), Vertical (V) . Flow Element: H, V. . Temperature Sensor: H, V. . Pressure Sensor: H, V. . Humidity Sensor: H, V. . Air Handling Unit, Single Deck. . Air Handling Unit, Double Deck. . Fan: RH, LH, U, D. . Chiller. . Boiler. . Vertical piping. . Horizontal piping. . Unit heater. . Pressure reducing valve: H, V. . Damper: H, V. . Electric Meter. . Limit switch: H, V. . Flow switch: H, V. . Temperature switch: H, V. . Pressure switch. . Coil: H, V.

TEST NO: Factory-16 Page 3 of 5
TITLE: Operator's Console Color Display
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that operates the operator's console and generates graphic displays.

EVENT	EXPECTED RESULTS
GRAPHIC DISPLAY	
6. Command the system to add custom symbols to the Library.	6. System requests input.
. Enter custom symbols	. System accepts input.
7. Command the system to display all graphic symbols.	7. Visually verify that all symbols, including custom symbols, are displayed.
8. Enter command to define a graphic display:	8. System executes commands as follows:
. Identify the background color	. Visually verify system displays requested background color.
. Identify the foreground color	. Visually verify system displays requested foreground color.
. Command the system to position the I/O function Alphanumeric descriptors at selected locations on the graphic.	. System requests locations of I/O function and executes command. Visually verify descriptors are located.
. Command the system to display new connecting lines between designated points.	. Visually verify system displays lines between designated points on the graphic display.
. Command the system to position standard graphic symbols from system library at selected locations on the graphics.	. Visually verify system positions of graphic symbols at selected locations.
. Command the system to save the display.	. System acknowledges command and saves the display.

TEST NO: Factory-16 Page 4 of 5
TITLE: Operator's Console Color Display
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that operates the operator's console and generates graphic displays.

EVENT	EXPECTED RESULTS
GRAPHIC DISPLAY	
9. Modify a portion of the display previously stored. (For example, add a new value, a controller or sensor.) Identify sources of live data and location of their readouts. Command the system to save the display under a new name and graphic designation.	9. Visually verify system overlays new alphanumeric and graphics on the existing display. Display is saved under the new name.
10. Call up a Graphic Display with the latest data on a specific system. (For example, request the latest data on an air handling unit.)	10. Visually verify system displays latest data as called for by the I/O Summary Tables, fully integrated with graphic display to at least 3 significant figures. Verify completeness of output against the I/O summary table provided by the contractor.
11. Initiate alarm condition(s) on a designated	11. Verify system displays red blinking alarm(s) on the designated graphic.
12. Acknowledge alarm.	12. Verify system displays steady red alarms on the graphic.
13. Eliminate alarm condition.	13. Verify steady red alarms are no longer displayed.
14. Command system to display data recognized as not current.	14. System displays data by highlighting or flagging.
15. Command the system to cancel the display of a graphic picture.	15. System removes display from CRT.
16. Command the system to display the graphic previously cancelled.	16. System recalls graphic from library and displays on CRT.

TEST NO: Factory-16 Page 5 of 5
TITLE: Operator's Console Color Display
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that operates the operator's console and generates graphic displays.

EVENT	EXPECTED RESULTS
GRAPHIC DISPLAY	
17. Assign conditions which automatically initiate the display. (For example, display after an alarm condition for the graphic.)	17. Graphic will be displayed automatically by events established in initial conditions.
18. Command the system to duplicate the graphic, assign it a new name and save it.	18. System duplicates the graphic, assigns it a new name, and saves it.
19. Delete the original graphic.	19. System deletes original graphic from library and cancels display on CRT.
20. Call up the original deleted graphic.	20. System does not display graphic and indicates graphic is not in library.

TEST NO: Factory-17 Page 1 of 1
TITLE: Operator's Console
APPLIES TO: Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that operates the operator's console.

INITIAL CONDITIONS

1. The contractor provides an I/O summary of the DE list for the test.
2. The DE is programmed to generate an event (such as an alarm) to test the software for displaying alphanumeric data after a specified event.
3. The contractor provides a sample new graphic to be developed during the test.

EVENT	EXPECTED RESULTS
ALPHANUMERIC DISPLAY	
1. Enter operator password to access the operator's console.	1. System acknowledges password.
2. Command the system to generate an alphanumeric CRT display of I/O functions by system or individual I/O points. (For example, request a CRT display of an air handling unit status).	2. Visually verify that the system displays the following data in fixed format: . Time of day (first field) . Day of week (first field) . Two analog functions (first field) . Operator name (first field) . Alarm display and operator interaction (second field) System displays in fixed format; the requested data. (third field)

TEST NO: Factory-18 Page 1 of 5
TITLE: Alarm Reporting
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which reports the alarm conditions with associated messages.

INITIAL CONDITIONS

1. The FID Test Set and DE is set up to initiate at least one of each of the following alarm conditions:

   - FID, MUX*, or IMUX not responding
   - FID-CCU/CCC** DTM high error rate
   - FID-CCU/CCC**-Real Time Clock error greater than 15 seconds (adjustable)
   - FID/MUX*/IMUX Door Intrusion Alarm
   - FID/MUX*/IMUX OFF LINE - control panel activated
   - FID/MUX*/IMUX ON LINE - control panel activated
   - FID/MUX*/IMUX OUTPUTS DISABLED - control panel activated
   - FID FAILURE - self diagnostics activated

2. Each type of the DE alarm is assigned an alarm class. All three alarm classes must be represented.

*3. At least one alarm in each class must have an associated message 60 characters long.

4. The contractor provides a priority list for each reporting alarm condition when all classes of alarms are initiated simultaneously.

EVENT	EXPECTED RESULTS
1. Log on to the system at a non-programmer, non-supervising operator access level.	1. System acknowledges log on.
2. Initiate all classes of alarms. Each class of alarms tested shall include a minimum of two operational alarms and two I/O functions for selected FID/MUX*/IMUX.	2. System sounds audible alarm, displays class 2 and 3 alarms on operator's console and prints class 1, 2 and 3 alarms with the following data for each alarm in order of priority identified in initial conditions:

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-18 Page 2 of 5
TITLE: Alarm Reporting
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which reports the alarm conditions with associated messages.

EVENT	EXPECTED RESULTS
2. (continued)	. Alarm identification. . Time of alarm condition. . Device or sensor type. . Limit exceeded (for analog functions). . Engineering units. . Current value or status. *. Primary alarm message with a 60 character field
*. Request secondary alarm messages for selected alarms.	*. Secondary messages with a ____ character field for requested alarms.
3. Request secondary messages for each class of selected alarms.	3. System displays secondary messages with a ___ character field for selected alarms.
4. Acknowledge Class 2 and Class 3 alarms.	4. System returns to normal operating mode.
5. Eliminate all alarm conditions.	5. System is in a normal operating mode.
6. Initiate Class 1 alarms.	6. System prints alarm report with the following data for each alarm in order of occurrence: . Alarm identification. . Time of alarm condition. . Device or sensor type. . Limit exceeded (for analog functions). . Engineering units. . Current value or status. *. Primary alarm message with a 60 character field
7. Eliminate conditions causing Class 1 alarms.	7. System prints updated status report and returns to normal operating mode.

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-18 Page 3 of 5
TITLE: Alarm Reporting
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which reports the alarm conditions with associated messages.

EVENT	EXPECTED RESULTS
8. Initiate Class 2 alarms.	8. System sounds an audible alarm, prints and displays the following data for each alarm in order of occurrence: . Alarm identification. . Time of alarm condition. . Device or sensor type. . Limit exceeded (for analog functions). . Engineering units. . Current value or status. *. Primary alarm message with a 60 character field
9. Acknowledge alarm(s).	9. Upon operator acknowledgement, system turns off audible alarm, displays alarm data for the alarms. Visually verify the system display indicates that the alarm(s) have been acknowledged.
10. Eliminate condition causing Class 2 alarms.	10. System displays and prints updated status report and returns to normal operating mode.
11. Initiate Class 3 alarms.	11. System sounds an audible alarm, prints and displays the following data for each alarm in order of occurrence: . Alarm identification . Time of alarm condition. . Device or sensor type. . Limit exceeded (for analog functions).

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-18 Page 4 of 5
TITLE: Alarm Reporting
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which reports the alarm conditions with associated messages.

EVENT	EXPECTED RESULTS
	. Engineering units. . Current or value status. *. Primary alarm message with a 60 character field
12. Acknowledge alarms.	12. Audible alarm ceases.
13. Eliminate conditions causing class 3 alarms.	13. System prints and displays updated status report and returns to normal operating mode. Audible alarm is operated indicating return to normal operating mode.
14. Acknowledge audible alarm.	14. Audible alarm is silenced.
15. Command the system to enable automatic silencing of a specified alarm.	15. System will indicate that command cannot be executed at the present operator access level.
16. Log off the system.	16. System acknowledges log off.
17. Log on with a password for an access level that enables the operator to activate automatic alarm silencing and/or initiate automatic acknowledgement of alarms.	17. System acknowledges log on.
18. Command the system to enable automatic audible alarm silencing of some, but not all Class 2 and Class 3 alarms.	18. System acknowledges and executes command.

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-18 Page 5 of 5
TITLE: Alarm Reporting
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the software which reports the alarm conditions with associated messages.

EVENT	EXPECTED RESULTS
19. Command the system to enable automatic acknowledgement of some but not all Class 2 and Class 3 alarms.	19. System acknowledges and executes command.
20. Initiate all Class 2 & 3 alarm conditions.	20. System automatically acknowledges those alarms specified for automatic acknowledgement. Audible alarm continues to sound for alarms not automatically acknowledged.
21. Acknowledge Class 2 and 3 alarms requiring such acknowledgement.	21. Audible alarm ceases.
22. Eliminate class 2 & 3 alarm conditions.	22. System displays and prints updated status report, sounds audible alarm for Class 3 alarms and returns to normal operation.
23. Command the system to report all points for which automatic alarm silencing and automatic alarm acknowledgement has been activated.	23. System displays all points with automatic alarm silencing and acknowledgement.
*24. Request display of primary and secondary alarm messages.	*24. Verify that sufficient storage space is allocated on disk to store a 60 character primary alarm message for every DE point with a possible alarm and _____ secondary messages of ____ characters each.

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-19 Page 1 of 1
TITLE: System Access Control
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the system to control operator access to EMCS software based on selectable passwords.

INITIAL CONDITIONS

1. The contractor provides a list of passwords for each access level and a list of software and commands accessible at each access level. All access levels required in the contract documents are tested.

EVENT	EXPECTED RESULTS
1. Log on with the password that corresponds to an access level and command the system to display software available at the given access level. Repeat for each access level.	1. System acknowledges log on and displays software accessible at the given access level. Visually verify the display matches the contractor's list.
2. For all but the highest access level, command the system to perform a function that cannot be performed at the current access level.	2. System indicates command cannot be executed at the current access level.
3. Log on with a password to access software for performing a specific function. (For example, command the system to set up high/low limits on analog point.)	3. Visually verify command is executed. (For example, observe change in high/low limit in a designated analog point.)
4. Log on with a higher access password and repeat software command in Event 3.	4. Visually verify command is executed.
5. Log on with a lower access password (that prevents access to software in Event 3) and repeat software command in Event 3.	5. System indicates command cannot be executed at current access level.
6. Repeat events 3, 4 and 5 for every remaining level.	6. Visually verify commands are executed only when the software and/or command is accessible at the given access level.

TEST NO: Factory-20 Page 1 of 2
TITLE: CCC Software Validation
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software for CCC normal mode operation.

INITIAL CONDITIONS

1. The contractor provides FID/MUX/IMUX I/O data to test CCC operation.

EVENT	EXPECTED RESULTS
1. Perform I/O functions in each FID/MUX/IMUX in the system from the operator's console.	1. Visually verify system performs requested I/O functions indicating communication with all parts of the system.
2. Remove from service 50% of the FID/MUX/IMUX communication links to the MCR.	2. System displays class 1 alarm for each DTM out of service.
3. Perform I/O functions from the operator's console for selected FID/MUX/IMUX communication links still in service.	3. Visually verify system performs requested I/O functions in connected FID/MUX/IMUX indicating communication with those parts of the system.
4. Introduce and maintain signals at FID/MUX/IMUX DTM which contains transmission errors that will prevent data from being correctly received by the CCC. (For example, use a spark, gap.)	3. CCC detects errors and closes down transmission to devices when the number of retransmission attempts exceeds the allowed maximum. System displays a Class 1 alarm for each DTM out of service.
5. Command the system to reopen communications to FID/MUX/IMUX out of service while the error signals are still on the line.	5. CCU tries to restart communication but communications are again shutdown when the number of retransmission attempts exceeds the allowed maximum. System displays a Class 1 alarm.
6. Enter command for summary report of errors detected in each communication link and the number of times each has been shutdown.	6. System displays total errors per communications link.

TEST NO: Factory-20 Page 2 of 2
TITLE: CCC Software Validation
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____ _____

OBJECTIVE: To demonstrate software for CCC normal mode operation.

EVENT	EXPECTED RESULTS
7. Remove error signals at FID/MUX/IMUX and manually reopen communications.	7. Transmission to devices out of service is reopened. System displays a class 1 alarm and returns to normal mode.
8. Perform I/O functions in each FID/MUX/IMUX in the system from the operator's console.	8. Visually verify system performs requested I/O functions indicating communication with all parts of the system.

TEST NO: Factory-21 Page 1 of 1
TITLE: CCC Programmer Control Function
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the CCC contains the required programmer control functions.

INITIAL CONDITIONS

1. The contractor provides the location and a listing of contents of selected memory locations on the CCC.
2. The contractor must provide a listing of CPU instructions to execute a set of tasks that can be visually verified by the operator.

EVENT	EXPECTED RESULTS
1. Command the system to load CCC software.	1. System loads required software.
2. Command the system to display contents of a specified main memory location.	2. System displays contents of designated main memory location. Verify that display agrees with contractor supplied listing.
3. Command the system to execute the specified tasks one at a time.	3. Visually verify tasks are executed in accordance with contractor supplied input.
4. Command the system to stop execution of the tasks.	4. System execution is stopped.
5. Manually alter program execution counter and manually step through part of the program.	5. Program counter is altered.
6. Command the system to continue execution of tasks.	6. Visually verify tasks resume execution where directed by the program counter.

TEST NO: Factory-22 Page 1 of 2
TITLE: FID Startup and Functions
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the FID can start operation automatically without human intervention. To demonstrate FID monitoring and control functions in normal operational mode and in stand-alone mode.

INITIAL CONDITIONS

1. The FID power switch is off. No battery backup is available. There is no data stored in the FID RAM. The DTM line to the CCU/CCC** is disconnected.

TEST EQUIPMENT

1. A FID portable diagnostic programming and bulk loading device.

EVENT	EXPECTED RESULTS
1. Power up the FID and connect portable diagnostic and bulk loading device.	1. Visually verify "POWER ON" lamps are lit.
2. Initiate the FID self-test diagnostics by actuating a switch on the control panel.	2. FID displays NO GO condition. All FID and associated MUX*/IMUX outputs must be in the predetermined failure mode defined in the I/O tables.
3. Enable the DTM to CCU/CCC**.	3. FID establishes communication with CCU/CCC**. The CCU/CCC** automatically sets the FID time clock, and downloads all parameters: alarms, constraints, and application programs. Visually verify FID indicates that it is on line.

* Large/Medium EMCS
**Large EMCS

TEST NO:	Factory-22 Page 2 of 2	OBJECTIVE: To demonstrate that the FID can start operation automatically without human intervention. To demonstrate FID monitoring and control functions in normal operational mode and in stand-alone mode.
TITLE:	FID Startup and Functions	
APPLIES TO:	Large, Medium and Small EMCS	
REFERENCE:	Proj. Spec. Paragraph _____	

EVENT	EXPECTED RESULTS
4. Verify operation of the following FID/MUX*/IMUX monitoring functions: . Scanning of inputs and outputs. . Report to CCU/CCC** of DE changes only. . Report to CCU/CCC** of DE status. . Averaging or filtering of all analog inputs. . Digital inputs alarm recognition.	4. Visually verify operator console display matches DE conditions.
5. Enter commands to operate the following FID/MUX*/IMUX control functions: . Constraints checks (prior to command issuance). . Control functions: digital output. . Control functions: analog output.	5. Visually verify operator command matches DE status.
6. Disconnect the DTM	6. FID is in stand-alone mode.
7. Exercise operation of the following FID resident application programs by accelerating the real time clock and/or OA temperature. . Scheduled start-stop. . Duty cycling. . Day-night setback. . [Optimum start-stop]. . [Ventilation-recirculation]. . Other programs required by the contract documents.	7. Visually verify the operation of FID I/O in accordance with the required outputs for each application program.

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-23 Page 1 of 1
TITLE: FID Software Programming
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the FID executes FID software programs and/or FID programs downloaded from the CCU/CCC** without CCU/CCC** intervention.

INITIAL CONDITIONS

1. The contractor provides written descriptions of the FID resident programs with the expected results.
2. The contractor provides a custom FID program to be loaded into the CCU.

EVENT	EXPECTED RESULTS
1. Develop in the CCU a custom FID program. (For example - start and stop all HVAC equipment connected to the FID in associated MUX*/IMUX at the same time every one-half hour with a time delay between successive starts). Download the program to the FIDs or create a new PROM for installation in the FID.	1. I/O function constraints must be checked prior to execution of command. Visually verify FID executes custom program by observing that equipment operates in accordance with the custom program (example - equipment cycles every one-half hour).
2. Inhibit communication between the CCU and FID.	2. Visually verify FID executes custom programs without communication with CCU as described in contractor furnished descriptions.

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-24 Page 1 of 1
TITLE: Analog and Digital I/O Functions
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the FID to execute commands from central control and monitor analog and digital functions.

TEST EQUIPMENT

1. A device that can generate 10 dry contact closures per second and can indicate the number of pulses transmitted.
2. FID Test Set.

EVENT	EXPECTED RESULTS
1. Change the state of two DE digital points (example - from on to off or from open to close) at selected FID/MUX*/IMUX.	1. System displays change of status of designated points.
2. Connect a 2 ampere 24 Vac 60 Hz electromagnetic relay coil to a digital output of a FID, MUX* and IMUX. Command digital output on and off.	2. Visually verify digital output operates as commanded.
3. Connect a pulse generator to a pulse accumulator input function. Generate contact closure at a rate of 10 pulses per second. Convert the total number of pulses generated, as shown on the pulse total indicator of the test equipment, into engineering units.	3. The number the engineering units displayed at the operator's console agree with the converted number of total number of pulses generated.
4. Connect a known analog signal to a analog input function of a FID, MUX* and IMUX. Provide engineering unit conversion.	4. The analog signal displayed at the operator's console agrees with the engineering unit conversion of the known analog signal input.
5. Connect an analog controller with remote reset capabilities to an analog output function of a FID, MUX* and IMUX. Provide engineering unit conversion. From the operator's console, command analog output to increase and decrease controller setpoint.	5. Visually verify that controller setpoints agree with operator's console setpoint commands, and system provides a feedback status on the controller setpoint.

*Large/Medium EMCS

TEST NO: Factory-25 Page 1 of 1
TITLE: Spare I/O Function
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the FID/MUX/IMUX has spare I/O capacity.

EVENT	EXPECTED RESULTS
1. Count spare I/O's in selected FID/MUX/IMUX.	1. Verify the number of spare I/O's corresponds with contract requirements.

*Large/Medium EMCS
°Large/Medium/Small EMCS

TEST NO: Factory-26 Page 1 of 1
TITLE: FID RTC and RAM Battery Backup
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the FID RTC and RAM to continue to operate and the RAM to maintain memory contents during power failures.

TEST EQUIPMENT

1. FID portable diagnostic test set.

EVENT	EXPECTED RESULTS
1. Remove the 120V AC from service from the FID for the duration of the battery backup as specified in the contract documents.	1. FID continues to operate in normal mode for the duration of battery backup. An alarm is displayed at the operator's console to indicate the FID is operating under battery backup.
2. At the end of the specified battery backup period, read RTC and selected RAM locations with portable diagnostic device.	2. Verify the FID time clock is operational with the correct time, and the FID RAM contents are maintained for the period of time specified.

TEST NO: Factory-27 Page 1 of 1
TITLE: FID/MUX*/IMUX Battery Backup
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of designated complete FID/MUX*/IMUX to operate under battery backup during power failures and to demonstrate recharging capabilities.

EVENT	EXPECTED RESULTS
1. Remove the 120 VAC power source from the FID/MUX*/IMUX and operate the FID/MUX*/IMUX for the time period required in the contract documents. Exercise FID/MUX*/IMUX by performing monitoring and control functions.	1. The FID/MUX*/IMUX continues to operate normally for the specified period under battery backup without degradation. An alarm is displayed at the operator's console to indicate the FID/MUX*/IMUX is operating under battery backup.
2. Turn on the 120 VAC power source to the FID/MUX*/IMUX.	2. The FID/MUX*/IMUX continues to operate normally.
3. Measure charging current to backup battery.	3. Verify batteries are being charges.

* Large/Medium EMCS

TEST NO: Factory-28 Page 1 of 1
TITLE: System Accuracy
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the system accuracy from sensor output to the operator's CRT display is within the specified limits.

TEST EQUIPMENT

1. A certified standard traceable to the National Bureau of Standards for each type analog signal to be tested.

2. The accuracy of the test equipment and overall test method is at least twice the accuracy of the most accurate sensor to be tested.

EVENT	EXPECTED RESULTS
1. Place certified standard at the terminals of each type of AI to be used in the EMCS. Command the system to display analog value.	1. Verify system display of analog value is within 0.5 percent of the range of the standard test equipment indicator across the entire range of AI, (zero, mid range size and full size).

TEST NO: FACTORY-29 Page 1 of 3
TITLE: System Reaction to Alarms
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the system reaction time to changes of status or analog alarms is within specified limits.

INITIAL CONDITIONS

1. DE is set up to initiate a system normal heavy load condition (as defined in the contract documents).
2. FID, MUX*, and IMUX's are set up to initiate a system normal heavy load with all FID/MUX/IMUX's and DTM on line.
3. It is recommended that the test be run during the slow period.

TEST EQUIPMENT

1. Stop watch with time intervals of 0.1 seconds.

EVENT	EXPECTED RESULTS
1. Command the system to display status of points selected to create normal heavy load conditions. (Status of points are to be displayed throughout the test).	1. System displays status of selected points.
2. Initiate sufficient number of alarms and status changes to create at least 10 successive occurrences of normal heavy load conditions as described in the specifications to perform each of events (2) through (5). (For example, in large EMCS, normal heavy load conditions occur when there are three status changes, three digital alarms, three analog high or low limit alarms, and three analog alarms within one second and for successive one second intervals for up to 30 seconds. Fifty percent of the changes and alarms,	2. Visually verify that status changes and alarms take place to create normal heavy load. Verify FID test set is connected to the communications link.

*Large/Medium EMCS

TEST NO: Factory-29 Page 2 of 3
TITLE: System Reaction to Alarms
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the system reaction time to changes of status or analog alarms is within specified limits.

EVENT	EXPECTED RESULTS
(Continued)	
including no less than one of each type, occur at a single FID/MUX*/IMUX, the remaining changes and alarms occur among the remaining FID/MUX*/IMUX)	
3. Initiate at least one of each class of analog alarms at a FID/MUX*/IMUX after the third successive occurrence of normal heavy load conditions. Time the delay between the analog alarm occurrence at each FID/MUX*/IMUX, and the display at the CRT.	3. Visually verify that the time delay between the initiation of the analog alarms and the initiation of the alarm display at the operator's console is no more that 10 seconds. Visually verify all alarms that occur during normal heavy load are ultimately displayed in order of priority.
4. Initiate at least one of each class of digital alarms at a FID/MUX*/IMUX on each type of DTM Link after the seventh occurrence of normal heavy load conditions. Time the delay between the alarm occurrence and the display at the CRT.	4. Visually verify that the time delay between the initiation of the analog alarm and the initiation of the new display at the operator's console is no more that 10 seconds. Visually verify all alarms that occur during normal heavy load are ultimately displayed in order of priority.
5. Initiate an analog alarm in a FID/MUX*/IMUX on each type of DTM Link after the ninth successive occurrence of normal heavy load conditions. Time the delay between the alarm occurrence and the display at the CRT.	5. Visually verify that the time delay between the initiation of the analog alarm and the initiation of the new display at the operator's console is no more than 10 seconds. Visually verify all alarms that occur during normal heavy load are ultimately displayed.
6. Initiate at least ten successive occurences of abnormal conditions as defined in the contract documents to perform each of the events seven through ten (for example - large EMCS, initiate conditions that are ___ times the normal heavy load).	6. Visually verify abnormal load conditions exist.

*Large/Medium EMCS

TEST NO: Factory-29 Page 3 of 3
TITLE: System Reaction to Alarms
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the system reaction time to changes of status or analog alarms is within specified limits.

EVENT	EXPECTED RESULTS
7. Initiate an analog alarm at a FID/MUX*/IMUX after the third successive occurrence of abnormal conditions. Time the delay between the analog alarm occurrence and the display at the CRT.	7. Visually verify that the response time for initiation of display and display of status change is no more than ___ times the response time under normal heavy load conditions. Visually verify all alarms that occur during normal heavy load are ultimately displayed.
8. Initiate a digital alarm at a FID/MUX*/IMUX after the fifth occurrence of abnormal conditions. Time the delay between the digital alarm occurrence FID/MUX*/IMUX and the console CRT display.	8. Visually verify that the response time for initiation of display and display of status change is no more than ___ times the response time under normal heavy load conditions. Visually verify all alarms that occur during normal heavy load are ultimately displayed.
9. Initiate an analog alarm on a FID/MUX*/IMUX on each type of DTM Link after the seventh occurrence of abnormal conditions. Time the delay between alarm occurrence and the display at the CRT.	9. Visually verify that the response time for initiation of display and display of status change is no more than ___ times the response time under normal heavy load conditions. Visually verify all alarms that occur during normal heavy load are ultimately displayed.
10. Initiate a digital alarm on a FID/MUX*/IMUX on each type of DTM Link after the ninth successive occurrence of abnormal conditions. Time the delay between alarm occurrence and the display at the CRT.	10. Visually verify that the response time for initiation of display and display of status change is no more than ___ times the response time under normal heavy load conditions. Visually verify all alarms that occur during normal heavy load are ultimately displayed.

*Large/Medium EMCS

TEST NO: FACTORY-30 Page 1 of 3
TITLE: System Reaction to Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the system reaction time to changes of status or analog alarms is within specified limits

INITIAL CONDITIONS

1. DE is set up to initiate a system, normal heavy load condition (as defined in the contract documents).
2. FID, MUX*, and IMUX's are set up to initiate a system normal heavy load with all FIDs/MUX/IMUX and DTM on line.
3. It is recommended that the test be run during a slow period.

TEST EQUIPMENT

1. Stop watch with time intervals of 0.1 seconds.

EVENT	EXPECTED RESULTS
1. Command the system to display the status of digital and analog points selected to create normal, heavy load conditions. (Status of points are to be displayed throughout the test.)	1. System displays status of selected points.
2. Initiate sufficient number of alarms and status changes to create at least 10 successive occurrences of normal normal heavy load conditions as described in the specifications for the following events (for example, in large EMCS, normal heavy load conditions occur when there are three status changes, three digital alarms, three analog high or low limit alarms, and three analog alarms within one second and for successive one second intervals for up to 30 seconds. Fifty percent of the changes and alarms, including no less than one of each type, occur at a single FID/MUX*/IMUX, the remaining changes and alarms occur among the remaining FID/MUX*/IMUX).	2. Verify the system displays the status changes and alarms which create normal heavy load conditions. Verify FID test set is connected to a communications link.

*Large/Medium EMCS

TEST NO: Factory-30 Page 2 of 3
TITLE: System Reaction to Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the system reaction time to changes of status or analog alarms is within specified limits

EVENT	EXPECTED RESULTS
3. Initiate a command to change the status of a point in FID/MUX*/IMUX after the fifth successive occurrence of normal heavy load conditions. Time the delay between the issue of the command to the FID/MUX*/IMUX in the DE and the processing, execution, and display of status change at the operator's console.	3. Visually verify that system commences to process operator command within five seconds of command entry. Visually verify that the time delay between the initiation of the command from the operator's console and the initiation of the command execution at DE is no more than 10 seconds. Visually verify that the time delay between the initiation of the command and the display of status change at the operator's console is no more than 20 seconds, plus the response time for the control device.
4. Command the system to execute each of the following: . Initiate reports. . Request graphic displays. . Modify time and event scheduling. . Modify analog limits. . Adjust setpoints of selected controllers. . Select manual or automatic control modes. . Enable and disable individual points; disabling shall take precedence over all other actions. . Enable and disable individual FID. . Enable and disable individual MUX* or IMUX panels. . Point definition.	4. Visually verify system commences to process operator commands within five seconds of command entry. Verify all commands are executed.
5. Initiate abnormal conditions as defined in the contract documents. (For example, in large EMCS, initiate conditions that are 10 times the normal heavy load.)	5. Visually verify abnormal conditions exist.

*Large/Medium EMCS

TEST NO: Factory-30 Page 3 of 3
TITLE: System Reaction to Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the system reaction time to changes of status or analog alarms is within specified limits

EVENT	EXPECTED RESULTS
6. Initiate a command to change of status of a point in FID/MUX*/IMUX after the third occurrence of abnormal conditions. Time the delay between the issue of a command to the FID/MUX*/IMUX DE and the display at the CRT that the command has been executed.	6. Visually verify that the time delay between the initiation of the command from the operator's console and the command execution at DE is no more than ____ times the response time under normal heavy load conditions.
7. Initiate the command to execute each of the following: . Initiate reports. . Request graphic displays. . Modify time and event scheduling. . Modify analog limits. . Adjust setpoints of selected controllers. . Select manual or automatic control modes. . Enable and disable individual points; disabling shall take precedence over all other actions. . Enable and disable individual FID. . Enable and disable individual MUX* or IMUX panels. . Point definition.	7. Visually verify that the time delay between the initiation of the command from the operator's console and the command execution at DE is no more than ____ times the response time under normal heavy load conditions.

*Large/Medium EMCS

TEST NO: Factory-31 Page 1 of 1
TITLE: Disk Data Base Update
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To determine the ability of the CCU during normal operation to update the DE parameters and the constraints to the disk data base file within 3 minutes.

TEST EQUIPMENT

1. A certified stopwatch with time intervals of 0.1 seconds.

EVENT	EXPECTED RESULTS
1. Command the system to store new values for memory resident parameters and constraints of selected analog/digital points in the DE. (For example, select analog high and low limit alarms and select start-stop times for digital output points.)	1. System requests data. System acknowledges input and stores data in memory.
2. Command the system to display new parameters and constraints from disk data files 3 minutes after new values are entered.	2. Visually verify System displays disk data files with revised parameter and constraints.

TEST NO: Factory-32 Page 1 of 2
TITLE: CCU Data Base Update
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the CCU to update the point data base within 15 seconds under normal heavy load conditions.

INITIAL CONDITIONS

1. The DE is set up to initiate a normal heavy load condition as defined in the contract documents.
2. The contractor provides a list of analog and digital points of each type in each FID/MUX*/IMUX to be used in the test.

TEST EQUIPMENT

1. A stopwatch with time intervals of 0.1 seconds.

EVENT	EXPECTED RESULTS
1. Command the system to display the status of digital and analog points selected to create normal heavy load conditions. (Status of points are to be displayed throughout the test.)	1. System displays status of selected points.
2. Initiate sufficient number of alarms and status changes to create at least 10 successive occurrences of normal heavy load conditions as described in the specifications to perform each of the events (2) through (5). (For example, in large EMCS, normal heavy load conditions occur when there are three status changes, three digital alarms, three analog high or low limit alarms, and three analog alarms within one second and for successive one second intervals. Fifty percent of the changes and alarms, including no less than one of each type, occur at a single FID/MUX*/IMUX, the remaining changes and alarms occur among the remaining FID/MUX*/IMUX)	2. Verify system displays the status changes and alarms which create normal heavy load conditions.

*Large/Medium EMCS

TEST NO: Factory-32 Page 2 of 2
TITLE: CCU Data Base Update
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the CCU to update the point data base within 15 seconds under normal heavy load conditions.

EVENT	EXPECTED RESULTS
3. After the third successive occurrence of normal heavy load conditions, change the value of an analog input to the DE. Time the delay between change of value and CCU data base update with corresponding display of value change at the CRT.	3. Verify CCU data base is updated with new analog input value within 15 seconds.
4. After the fifth successive occurrence of normal heavy load conditions, change the value of an analog output to the DE. Time the delay between change of value and CCU data base update with corresponding display of value change at the CRT.	4. Verify CCU data base is updated with new analog output value within 15 seconds.
5. After the seventh successive occurrence of normal heavy load conditions, change the status of an digital input to the DE. Time the delay between change of status and CCU data base update with corresponding display of status change at the CRT.	5. Verify CCU data base is updated with new digital input status within 15 seconds.
6. After the ninth successive occurrence of normal heavy load conditions, change the status of an digital output to the DE. Time the delay between change of status and CCU data base update with corresponding display of status change at the CRT.	6. Verify CCU data base is updated with new digital output status within 15 seconds.

*Large/Medium EMCS

TEST NO: Factory-33 Page 1 of 1
TITLE: CCU Time Base Generator
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the difference between the CCU time base generator (TBG) and the system RTC is within specified limits of error.

INITIAL CONDITIONS

1. RTC and CCU TBG are synchronized.

EVENT	EXPECTED RESULTS
1. Manually reset the system RTC and CCU TBG to obtain an alarm.	1. An alarm is generated indicating the CCU TBG error.
2. System interrogates the RTC automatically.	2. System corrects the TBG so that it agrees with the RTC (within one second).

TEST NO: Factory-34 Page 1 of 1
TITLE: CCC Time Base Generator
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the difference between CCC time base generator (TBG) and the system RTC is within specified limits of error.

INITIAL CONDITIONS

1. RTC and CCC TBG are synchronized.

EVENT	EXPECTED RESULTS
1. Manually reset the CCC time clock so that it differs from the RTC to obtain an alarm.	1. An alarm is generated indicating the CCC TBG error.
2. System interrogates CCU TBG.	2. System corrects the CCC TBG so that it agrees with the CCU TBG (minutes and seconds). Read CCC TBG and verify synchronization.

TEST NO: Factory-35 Page 1 of 1
TITLE: FID Real Time Clock
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the FID real time clock error is within specified limits.

INITIAL CONDITIONS

1. CCU/CCC** TBG and FID RTC are synchronized.

TEST EQUIPMENT

1. FID portable diagnostic device.

EVENT	EXPECTED RESULTS
1. Connect FID portable diagnostic device and reset FID real time clock (RTC) to be out of synchronization.	1. The system reports an alarm indicating RTC and TBG out of synchronization. Verify FID RTC and CCU/CCC** time base generator are not synchronized.
2. The CCU/CCC** TBG resets the FID RTC.	2. System corrects the FID RTC so that it agrees with the CCU/CCC** RTC (minutes and seconds).
3. Connect FID portable diagnostic device and read FID real time clock (RTC).	3. Verify FID RTC and CCU/CCC** TBG are synchronized.

**Large EMCS

TEST NO: Factory-36 Page 1 of 3
TITLE: Command Priorities
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify the software that controls the priority in which commands are executed (for example, the software prevents a low priority command from interfacing with a high priority command).

INITIAL CONDITIONS

1. Prior to the test, the contractor provides a schedule of commands for testing command priorities. In the test, at least one of each of the following command priorities are assigned to specific applications programs.

   . Level 1 - a routine operation such as scheduled start/stop and operator inputs.
   . Level 2 - a modifying program to the Level 1 requirement, such as duty cycling.
   . Level 3 - a modifying program to the Level 1 and Level 2 requirements, such as demand limiting.
   . Level 4 - an override by access to a high level password.

2. Each program level must cause unique and identifiable change in equipment operation relative to the other program, and DE conditions must be designed so that changes in operation take place as soon as higher level programs are executed. (For example, establish unique but overlapping time periods for equipment start-up and duty cycling where duty cycling occurs after equipment start-up. Also, prescribe a demand limit that will be exceeded by demand during duty cycling period so that equipment cycling under a lower priority command will be interrupted.)

3. Establish an equipment operating constraint or environmental constraint that visibly modifies or prevents a desired change in equipment operation. For example, establish a condition that will decrease and increase the duty cycling periods, establish conditions that will cause the duty cycle period to be exceeded during high demand periods, and establish conditions that will cause the "fairness doctrine" to be used.

EVENT	EXPECTED RESULTS
1. Log onto system with a non programmer, non-supervising operator password.	1. System acknowledges log-on.
2. Command the system to execute Level 1 priority command (for example - scheduled start/stop) on selected equipment.	2. System executes the command. Visually examine DE status changes.

TEST NO: Factory-36 Page 2 of 3
TITLE: Command Priorities
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify the software that controls the priority in which commands are executed (for example, the software prevents a low priority command from interfacing with a high priority command).

EVENT	EXPECTED RESULTS
3. Command the system to execute a Level 2 priority command that will interrupt the execution of the Level 1 priority command (example - duty cycling).	3. System executes the command. Equipment formally controlled by the level 1 priority command is controlled by the level 2 priority command. Visually verify the change in the operation of the equipment formally controlled by the level 1 priority command (example - executed duty cycling on equipment currently under scheduled start/stop).
4. Command the system to execute a Level 3 priority command (example - demand limiting).	4. System executes the command. Equipment formally controlled by the level 2 command is controlled by the level 3 command. Visually verify the change in the operation of equipment formally controlled by the level 2 priority command. (For example, execute a demand limiting program on equipment currently in the duty cycling mode.)
5. Command the system to execute a Level 1 priority command.	5. System indicates command cannot be executed because current command has a higher command priority.
6. Command the system to execute a Level 2 priority command.	6. System indicates command cannot be executed because current program has a higher command priority.
7. Command the system to execute a Level 4 priority command. (For example, command the system to keep equipment in operation regardless of demand limit program.)	7. System indicates command cannot be executed at current operator access level.
8. Command the system to decrease demand limiting target to a level that will require the implementation of the "Fairness Doctrine" in the demand limiting program.	8. Verify that temperatures in all areas deviates equally from the established operating setpoints.
9. Log off the system.	9. System acknowledges log off.

TEST NO: Factory-36 Page 3 of 3
TITLE: Command Priorities
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify the software that controls the priority in which commands are executed (for example, the software prevents a low priority command from interfacing with a high priority command).

EVENT	EXPECTED RESULTS
10. Log on to the system with a sufficiently high level password to access level 4 priority commands.	10. System acknowledges log on.
11. Command the system to execute a Level 4 priority command. (For example, cause equipment to operate even though current peak demand conditions would cause equipment shutdown under the Level 3 command.)	11. System acknowledges and executes command. Visually verify the changes the operation of equipment currently controlled by the level 3 command.

TEST NO: Factory-37 Page 1 of 1
TITLE: Analog Commands
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate use of the Analog Output (AO) or Digital Output (DO), in conjunction with the Analog Input (AI) signals for control point adjustment (CPA).

INITIAL CONDITIONS

1. DE points are designated as control point and position adjustment points.

EVENT	EXPECTED RESULTS
1. Log on to the system with password that permits control point adjustments.	1. System acknowledges log on.
2. Command discrete amount of changes in control point adjustment (CPA). (For example, reset temperature setpoint from 48° to 45°F.)	2. Visually verify in the field, the execution of control point adjustments on a controller.
3. Request display of CPA status.	3. System provides display with new control point adjustment setpoint.
4. Command discrete amount of changes in a position adjustment point. (For example, change damper position adjustment (DPA) from 10% open to 50% open).	4. Visually verify the execution of the position adjustment point.
5. Request display of position adjustment point.	5. System provides display with new position adjustment point.

TEST NO: Factory-38 Page 1 of 2
TITLE: Alarms
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of software that recognizes and displays digital and analog alarms.

INITIAL CONDITIONS

1. DE I/O functions have been assigned alarm classes and parameters via the DE definition process. At least one of each type of alarm class is represented in the DE.

EVENT	EXPECTED RESULTS
1. Log on to the system.	1. System acknowledges log on.
2. Initiate, manually in the DE, a change of state on selected digital I/O functions in each alarm class that will generate alarms. (For example, manually turn off equipment for which status alarm is available and has been commanded to be "ON" by the system.)	2. System generates and displays digital alarms based on their alarm classes. Verify the alarm display includes the following: . Alarm identification. . Time of occurrence. . Device or sensor type. . Current status.
3. Initiate, manually in the DE, a change of state on selected analog I/O functions in each alarm class that will generate alarms. (For example, manually cause an analog point to exceed the high or low analog setpoints.)	3. System operates and displays analog alarms based on their alarm classes. Verify the alarm displays include the following: . Alarm identification. . Time of occurrence. . Device or sensor type. . Limit exceeded. . Engineering units. . Current value.
4. Command the system to assign new limits and differentials to some but not all analog points currently in alarm condition.	4. System requests input. Visually verify all analog points currently in alarm condition remain in alarm condition.

TEST NO: Factory-38 Page 2 of 2
TITLE: Alarms
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of software that recognizes and displays digital and analog alarms.

EVENT	EXPECTED RESULTS
5. Input values that will bring some but not all analog points out of alarm condition. Specify change is to take place after __ minutes.	5. System acknowledges input. After ____minutes, visually verify designated alarms with new limits are no longer in alarm condition, while analog points with unchanged limits remain in alarm condition.
6. Command a change of state for selected digital points that are mechanically disabled, and for which status is available (such as a fan out of service for maintenance).	6. System acknowledges and executes command. Alarm is generated since status point cannot verify change of state for digital point.
7. Command a change of status for selected analog points that are mechanically disabled and for which status is available (such as an automatic damper in a fan system that is out of service for maintenance).	7. System acknowledges and executes command. Alarm is generated since status point cannot verify change of state for analog point.
8. Command the system to turn off digital points in some but not all equipment with analog alarms.	8. Verify system suppresses analog alarms for equipment with digital points off. Verify analog alarms are still displayed for equipment with digital points on.
9. Initiate a normal change of status (such as a scheduled start/stop).	9. Verify system displays change of status without generating an alarm.

TEST NO: Factory-39 Page 1 of 1
TITLE: Calculated Point
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that creates new point values by performing mathematical operations on any values available in the system data base.

INITIAL CONDITIONS

1. Specified DE points are set up to generate known analog, digital and constant values required for the computation of point values. Input values are selected so that calculated values can be predicted.

2. The contractor provides a schedule of data base values of calculated points to be used in the test with the expected results.

EVENT	EXPECTED RESULT
1. Command the system to display calculated point values based on predetermined data base values and mathematical operations (such as square roots and exponents).	1. System displays point identification and values which correspond with predicted values. Display format is the same as any analog point format.
2. Command the system to change specified constants for computation of point values. Enter the new constant(s).	2. System acknowledges input.
3. Command the system to display revised calculated point values.	3. System displays new values for calculated points along with point identification. New values correspond with predicted results using the new constant(s).

TEST NO: Factory-40 Page 1 of 1
TITLE: Analog Monitoring
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate system capability to monitor all analog values, including calculated analog points.

INITIAL CONDITIONS

1. The contractor provides a list of analog points including calculated points.

EVENT	EXPECTED RESULT
1. Command the system to display analog points, including calculated analog points.	1. System acknowledges command and displays the analog points with their descriptors and alphanumeric values.
2. Command the system to input high and low limits alarm values for selected analog points.	2. System acknowledges data input.
3. Initiate a change of value of selected analog points at the FID/MUX*/IMUX within the high and low limits.	3. System displays value of new value of preselected points without alarm indication.
4. Initiate a change of value for selected analog points at the FID/MUX*/IMUX that will generate alarms, including an alarm for a calculated point.	4. System displays value of selected points and generates an alarm for each analog point in alarm.

*Large/Medium EMCS

TEST NO: Factory-41 Page 1 of 2
TITLE: Analog Totalization
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate operation of software that transmits, displays, and totalizes analog values over a given time period.

INITIAL CONDITIONS

1. The contractor provides a list of analog points with known analog values so that totalization over at least three predetermined time periods for each point can be computed as a check against the system totalization for each point.

2. The selected analog points include calculated analog points.

3. The totalization values for each point must be unique for each time period. Time periods for each point must be different.

EVENT	EXPECTED RESULTS
1. Command the system to display and monitor selected designated analog points.	1. System acknowledges command and displays alphanumeric values. Verify system display against known values.
2. Enter the point identification and time period for totalizing each point. Select different time period and time intervals so that at least three outputs occur in the course of the test. Request system display of totalized values.	2. System executes analog totalization program at designated time periods for each point. For each designated point system displays: . Peak value in current time period. . Total value in current time period. . Peak value in previous time period. . Total value in previous time period. Verify system output against predetermined values.

TEST NO: Factory-41 Page 2 of 2
TITLE: Analog Totalization
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate operation of software that transmits, displays, and totalizes analog values over a given time period.

EVENT	EXPECTED RESULTS
3. Command the system to change end of time period for each totalized point. Request system display of totalized values.	3. System executes command and displays: . Peak value in current time period. . Total value in current time period. . Peak value in previous time period. . Total value in previous time period. Verify system display matches expected results.
4. Enter command for system display of analog totals for each time period.	4. Verify system display of analog totals matches expected results.

TEST NO: Factory-42 Page 1 of 1
TITLE: Energy Totalization
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of software that totalizes heating energy consumption for each energy source.

INITIAL CONDITIONS

1. The contractor provides a list of points with known values so that totalization over at least three predetermining time periods for each point can be computed as a check against the system totalization for each point.

2. Selected points required for totalization are set up to fail during the totalization period.

EVENT	EXPECTED RESULTS
1. Command the system to initiate energy totalization for selected points.	1. System acknowledges command, and requests point identification and time period for totalization for each point.
2. Enter system identification and time period for totalization. Select a different time period so that totalization occurs at least 3 times in the course of the test period.	2. System executes energy totalization program at designated time periods for each system.
3. At the end of the second time period, command the system to display totalization values for each point. Disable selected input points.	3. System displays the heat energy (in thousand BTU's) consumed during the time period and the instantaneous rate in BTU per hour for each point. System displays and flags the estimated values for disabled points. Verify system output against known values.
4. At a predetermined time during the third time period, command the system to change the end of period time for each totalized point.	4. System acknowledges command and terminates totalization for the third time period.
5. Enter command for energy totalization data for the third time period.	5. System displays energy totalization values for the shortened time period with a flag for those points with estimated values.

TEST NO. Factory-43 Page 1 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

INITIAL CONDITIONS

1. The system is programmed to generate hourly, daily, and monthly values for each type of report.

2. The preselected points to be included in the reports must include the following address levels:

   . Point
   . Equipment unit
   . Building
   . Area
   . [Installation]
   . Entire EMCS

3. Preselected output points for each specified report type are set up to become disabled during the test period.

4. Preselected output points for each specified report type are set up to be in alarm condition during the test period. Select alarm points so that each alarm class is represented.

5. Electric demand intervals are defined in the system software.

6. Target run times have been established for each selected equipment item via the DE definition process.

7. Selected equipment run-time totals are set up to be 9,999 hours. Other selected equipment are set up to have reached their target.

8. The system is set up to have chiller utilization data for at least 10 discrete loading levels, including run-time for each load level and total run-time.

9. Selected building indoor temperature points are set up to maintain temperature levels below required occupancy temperatures throughout test period.

TEST NO. Factory-43 Page 2 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

EVENT	EXPECTED RESULT
ELECTRICAL POWER UTILIZATION SUMMARY:	
1. Command the system to generate the Electrical Power Utilization Summary.	1. System requests meter identification and time period.
2. Enter meter identification(s). Request daily and monthly totals. Specify the date of beginning day of the month.	2. System generates the following data for each meter: . Total daily consumption. . Total monthly consumption for the specified period. . Peak electric demand interval for the month and day, with time of occurrence. . Consumption over each demand interval for the month. . OA temperature for each demand interval. . OA relative humidity for each demand interval. . Calculated heating and cooling degree days.

TEST NO. Factory-43 Page 3 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

EVENT	EXPECTED RESULT
ENERGY UTILIZATION SUMMARY:	
1. Command the system to generate the Energy Utilization Summary.	1. System requests identification of the point, unit, building, area, and/or [installation]. System requests beginning and ending times for sampling intervals.
2. Enter identification of desired I/O points according to each of the following address levels: . A specific point in each DTM. . A unit in each DTM. . A building in each DTM. . An area. . [Installation] . The entire EMCS.	2. System generates a report for each address level. Each report must contain: . Beginning and ending dates and times. . Total energy usage for the current and previous day. . Total energy usage for the current and previous month. . Maximum rate of consumption for the current and previous day. . Maximum rate of consumption for the current and previous month. . OA temperature and relative humidity for the sampling period (high, low, average). . Calulated heating and cooling degree days.
ALARM SUMMARY:	
1. Command the system to generate the Alarm Summary.	1. System generates a report listing all outstanding alarms by class, including time of occurrence.
LOCKOUT SUMMARY:	
1. Command the system to generate the Lockout Summary.	1. System generates a report listing all points currently disabled, including time disabled, and identification of operator disabling the point.

TEST NO. Factory-43 Page 4 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

EVENT	EXPECTED RESULT
ANALOG LIMIT SUMMARY:	
1. Command the system to generate the Analog Limit Summary.	1. System generates a report with the following data for each analog point including those with suppressed alarm functions. . Identification. . Current analog value. . Engineering units. . High and low limits. . Limit differentials.
2. Command the system to generate the Analog Limit Summary by building and by building unit.	2. System generates a report with the following data for each analog point including those with suppressed alarm functions. . Identification. . Current analog value. . Engineering Units. . High and low limits. . Limit differentials.

TEST NO. Factory-43 Page 5 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

EVENT	EXPECTED RESULT
RUN-TIME REPORTS:	
1. Command the system to generate the Run-Time Report.	1. System requests identification of equipment.
2. Enter identification of desired equipment according to each of the following address levels: . Individual equipment items (example - fan unit A in Building 1) . An equipment type (example - all air handling units). . An equipment type and size (example - all air handling units over 10 horsepower). . Equipment by physical grouping (example - HVAC System I). Equipment must have run times of 9,999 hours (as established in initial conditions). Include equipment which has reached their respective run-time target (as established in initial conditions). . All equipment.	2. System generates a report that provides the total run-time for each equipment unit in each address level.
3. Manually reset run time to zero for selected equipment and request Run-Time Report for the equipment.	3. System generates a Run-Time Report based on new time origin.

TEST NO. Factory-43 Page 6 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

EVENT	EXPECTED RESULT
COOLING TOWER PROFILES:	
1. Command the system to generate the Cooling Tower Profile.	1. System requests cooling tower identification.
2. Enter cooling tower identification.	2. System acknowledges input and generates a report that provides: . Total daily and monthly on-time (each fan). . Number of ON and OFF transitions (each fan). . Maximum and minimum daily condenser water temperature at the time the cooling tower was turned on, and the time of occurrence. . Maximum and minimum daily condenser water temperature for the current month.
ELECTRICAL PEAK DEMAND PREDICTION REPORT:	
1. Command the system to generate the Electrical Peak Demand Prediction Report.	1. System requests meter identification.
2. Enter definition for individual meter or groups of meters to be totalized.	2. System acknowledges input and generates a report for each meter or groups of meters that provides: . Target. . Actual peak and predicted peak for each demand interval for that day. . Predicted demand for the next demand interval.

TEST NO. Factory-43 Page 7 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: *Proj. Spec. Paragraph* _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

EVENT	EXPECTED RESULT
CHILLER UTILIZATION SUMMARY:	
1. Command the system to generate the Chiller Utilization Summary.	1. System requests chiller identification.
2. Enter chiller identification.	2. System generates the chiller utilization summary report that provides: . Daily run-time in each one of at least 10 discrete loading levels. . Daily run-time average for the above discrete loading levels. . Total on-time for each level for the current month. . Run-time monthly average expressed in kWh and BTU/Hr for the total on-time at each level.
OPTIMUM START/STOP REPORT:	
1. Command the system to generate the Optimum Start Report for all systems and buildings.	1. System generates report that lists the systems or buildings not meeting occupancy temperature requirements within plus or minus 20 minutes of designated time, updated daily or upon request. The report provides: . System and building identification. . Building occupancy schedule. . Actual start time. . Calculated start time. . Space temperature at beginning of occupancy. . OA temperature at beginning of occupancy.

TEST NO. Factory-43 Page 8 of 8
TITLE: Reports
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software for generating the reports required in the contract documents.

EVENT	EXPECTED RESULT
2. Command the system to generate the Optimum Stop Report for all systems and buildings.	2. System generates report that lists the systems or buildings not maintaining occupancy temperature within 20 minutes of designated time, updated daily or upon request. The report provides: . System and building identification. . Building occupancy schedule. . Actual stop time . Calculated stop time. . Space temperature at end of occupancy. . OA temperature at end of occupancy.
OUT OF SERVICE REPORT:	
1. Command the system to generate the Out-of-Service Report.	1. System requests report schedule and locations to be reported.
2. Enter requests for reports on equipment at each of the following locations: . MCR . DTM link . FID panel *. MUX panel . IMUX panel	2. System generates out of service reports for each location. The reports list all disabled points.
POINTS SUMMARY:	
1. Request an all points summary report.	1. System generates a listing of the current status of all I/O points in the system (taken as a snapshot at the same time).

*Large/Medium EMCS

TEST NO: Factory-44 Page 1 of 1
TITLE: Prediction Software
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that performs an extrapolation on data into future of analog values based on past analog values.

INITIAL CONDITIONS

1. The contractor provides a curve of known characteristics with at least eight analog values and expected output based on the curve. (At least two sets of input/output data provided. Each input set is spaced over a different time scale).

2. The Government provides a curve of know characteristics with at least eight analog values and expected output based on the curve. (At least two sets of input/output data provided. Each input set is spaced over a different time scale).

3. The system is programmed to use the known curve in the prediction program.

EVENT	EXPECTED RESULTS
1. Initiate the prediction program for the curve defined in initial conditions. Command the the system to display predicted values.	1. System requests input data and time spacing of values to be extrapolated, and calculates predicted value into future for each point in the curve. Verify system display of predicted value corresponds to expected value.
2. Enter command to vary (increase or decrease) time spacing of values used in the prediction program. Command the system to display the predicted value.	2. System calculates predicted value. Verify system display of predicted value corresponds for each point in the curve to the expected value.
3. Enter Government furnished curve. Command the system to identify the predicted value.	3. System calculates predicted value. Verify system display of predicted value corresponds for each point in the curve to the expected value.

TEST NO: Factory-45 Page 1 of 2
TITLE: Time Programs
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that automatically controls equipment on a predetermined schedule.

INITIAL CONDITIONS

1. Specified points in the DE indicate the status of equipment start/stop activity.
2. System is programmed to execute equipment start/stop program.

EVENT	EXPECTED RESULTS
1. Enable the system to execute start/stop program.	1. At designated times, the system executes start/stop program with the programmed time delay between successive starts of equipment. Visually verify equipment is started and shutdown at designated time periods. For scheduled successive starts, visually verify there is sufficient time between successive starts to prevent a power surge.
2. Command the system to accept ____ value sets of on/off times or event initiation times for each day of the week and for a holiday on designated equipment. Enter value sets such that some start-up times will require a time delay between starts.	2. System acknowledges input.
3. Command the system to generate the time program assignment report.	3. System generates report that contains start/stop schedules for each point or function by: . Time of day . Day of week . Holiday Assignments
4. Command the system to modify existing schedule.	4. System acknowledges revised shedules.

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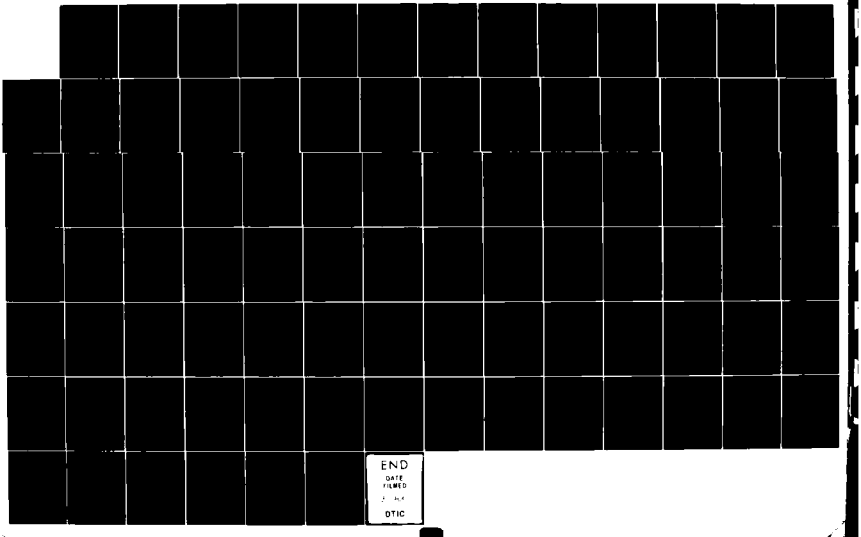

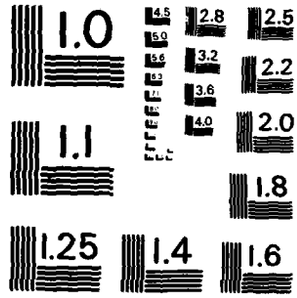

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TEST NO: Factory-45 Page 2 of 2
TITLE: Time Programs
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that automatically controls equipment on a predetermined schedule.

EVENT	EXPECTED RESULTS
5. Enter start/stop times that are less than the time delay constraints.	5. System indicates command cannot be executed because the schedules exceed equipment constraints.
6. Modify time delay constraint so that Event 5 can be executed (without damaging equipment).	6. System executes start/stop program with new programmed time delay between successive starts of equipment.

TEST NO: Factory-46 Page 1 of 1
TITLE: Event Programs
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate operation of software that allows manual or automatic initiation of programs based on hardware or software events.

INITIAL CONDITIONS

1. The contractor provides an algorithmic control sequence that controls points in the DE. (For example, use an algorithmic control sequence based on outside air and indoor air temperatures affecting damper positions).

2. Selected points in the DE are programmed to be activated by this control sequence.

EVENT	EXPECTED RESULTS
1. Initiate, manually, a change of OA that will activate the algorithmic control sequence. (For example, change the outside air temperature to cause a change in the damper position).	1. The system automatically executes the algorithmic control sequence. Visually verify program is executed against contractor furnished data.
2. Initiate, manually, a change of building indoor air and OA temperatures that will activate the algorithmic control sequence.	2. The system executes the algorithmic control sequence. Visually verify program is executed against contractor furnished data.
3. Command system to manually initiate the algorithmic control sequence regardless of OA and building indoor air temperature.	3. The system executes the algorithmic control sequence. Visually verify program is executed in accordance with contractor furnished data.
4. Set up an alarm condition that initiates an automatic control sequence. (For example, low temperature alarm causing fan shutdown).	4. Verify system displays alarm. Verify system executes algorithmic control sequence.

TEST NO: Factory-47 Page 1 of 1
TITLE: Extended Service Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate operation of software that allows one-time extensions of timed equipment schedules.

INITIAL CONDITIONS

1. Specified points in the DE indicate the status of equipment start/stop activity.
2. The contractor provides ___ distinct extended service programs with ____ pieces of equipment per program.

   All programs are loaded on to the system.
3. All equipment affected by the extended service programs is set up to start up and shut down at specified times.
4. The contractor identifies the input commands for requesting extended service for a given schedule.
5. All selected equipment is initially off.

EVENT	EXPECTED RESULTS
1. Command the system to execute the time program for all equipment selected for the extended service program.	1. Visually verify equipment starts up according to the scheduled start times.
2. Prior to the scheduled stop time, initiate appropriate inputs to request extended service on some but not all of the equipment schedules.	2. Visually verify equipment shuts down for schedules without extended service request, while equipment under extended service schedules remain in operation.
3. Command the system to modify the extended service program.	3. System requests identification of equipment and schedule.
4. Enter modified extended service programs for selected pieces of equipment.	4. System acknowledges input of all schedules and equipment. Visually verify service change in the operation of equipment as a result of the modified programs.

TEST NO: Factory-48 Page 1 of 1
TITLE: Scheduled Start/Stop Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software to start and stop equipment based on time of day and day of week, including holidays.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of equipment start/stop activity every day of the week and holidays, during summer and winter. Summer and winter schedules are different. The contractor provides the following information for the units to be tested:

   . Summer or winter operation - cause heating equipment operation for one test period and cooling operation for another test period.
   . Equipment schedules - to start and stop equipment during the test period.
   . Equipment status - (example - to be off initially).

2. The system is programmed to execute the scheduled start/stop program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Command the system to execute the scheduled start/stop program for all equipment selected for the test.	2. Visually verify equipment starts up and shuts down down in accordance with the schedule.
3. Start up and stop equipment manually at the unit by overriding the system controls.	3. Visually verify the system generates an alarm to indicate unauthorized starting or stopping of equipment.

TEST NO: Factory-49 Page 1 of 2
TITLE: Optimum Start/Stop Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software to start and stop equipment on a sliding schedule based on indoor and outdoor air conditions.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of equipment that starts and stops every day of the week and holidays during the summer and winter schedules. (Summer and winter schedules are different.)
2. The contractor provides equipment schedules that coincide with the test period.
3. The values must be selected so that the software for both heating and cooling units are tested.
4. The contractor provides the formulas and explanation for predicting optimum start/stop times.
5. The contractor provides the predicted values for optimum start/stop times based on input data on outside air temperature and relative humidity, on building characteristics (occupancy, temperature, and thermal factors) and on equipment operating characteristics as required in the contract documents.

6. A run-time report is requested for the points selected for this test.

EVENT	EXPECTED RESULTS
1. Command the system to execute the optimum start/stop program. Command the system to display status of equipment used in the test.	1. System executes the optimum start/stop program. Visually verify the system displays start and stop times that match the predicted optimum start/stop times.
2. Manually attempt to change point status from start to stop by overriding the system controls.	2. System generates alarms and indicates unauthorized start or stop of equipment.

*Large/Medium EMCS

TEST NO: Factory-49 Page 2 of 2
TITLE: Optimum Start/Stop Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software to start and stop equipment on a sliding schedule based on indoor and outdoor air conditions.

EVENT	EXPECTED RESULTS
3. Change (increase) space temperature setpoint (for heating systems) for start-up and command the system to display equipment status.	3. Verify system displays start times that match predicted results (earlier start times than previous start times).
4. Change (decrease) space temperature setpoint (for cooling systems) for start-up and command the system to display equipment status.	4. Verify the system displays start times that match predicted results (earlier start times than previous start times).

TEST NO: Factory-50 Page 1 of 2
TITLE: Duty Cycling Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that causes equipment shutdown for predetermined periods of time during building occupied hours in accordance with ___ different classes of equipment.

INITIAL CONDITIONS

1. Specified points in the DE indicate the status of equipment that starts and stops every day of the week and holidays, during the summer and winter schedule. (Summer and winter schedules are different.)
2. The contractor provides equipment schedules that coincide with the test period.
3. The values must be selected so that the software for both heating and cooling units is tested.
4. Each point is assigned an equipment class. All ___ equipment classes are represented in the test.
5. The contractor provides an explanation of how the system increases or decreases the cycling intervals relative to space temperature conditions. The contractor provides the predicted values for a change in the cycling for interval based on input data on space temperature changes.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Command the system to execute the duty cycling program. Command the system to display equipment status.	2. System executes the duty cycling program. Visually verify the DE point status corresponds to the predicted on-off cycle intervals. The system displays the change of status and a start or stop signal for each unit. Check units for time delay between successive starts of equipment.

TEST NO: Factory-50 Page 2 of 2
TITLE: Duty Cycling Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that causes equipment shutdown for predetermined periods of time during building occupied hours in accordance with ___ different classes of equipment.

EVENT	EXPECTED RESULTS
3. Initiate a change in space temperature to cause a visible change in the duty cycling of selected equipment. (For example, initiate a higher space temperature, resulting in shorter shorter "off" times for cooling equipment or longer "off" times for heating equipment).	3. Visually verify a change in cycling times of selected equipment and in system display of point status.
4. Enter command to change equipment duty cycle duration.	4. System requests equipment identification and new cycling time.
5. Enter point identification and new cycling interval.	5. System executes command. New cycling interval replaces old cycling interval for selected equipment. Visually verify changes in cycling intervals for selected equipment.

TEST NO: Factory-51 Page 1 of 2
TITLE: Demand Limiting Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that sheds electrical loads for peak demand control using prediction techniques to avoid exceeding preestablished peak demand values.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of equipment included in the demand limiting program.
2. Equipment schedules coincide with the test period.
3. The contractor provides the necessary information per equipment unit (as required in the contract documents) such that the operation of the unit can be predicted during the test period.
4. Each equipment unit is assigned a priority class. All priority classes must contain at least two units.
5. Selected equipment is assigned constraints that will prevent a desired change in equipment operation.
6. The contractor provides data for determining power demand from fixed demand interval meters with and without end of interval signal, from "sliding window" intervals, and for time of day metering.
7. The test period demand levels are set up to exceed the peak demand target at least two times such that all equipment assigned to demand limiting program will be shutdown and started up at least two times during the test period.
8. The system is programmed to generate the electrical peak demand report for each day in the test period.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate power demand levels which are predicted to exceed peak demand target.	2. System executes demand limit program which sheds electrical loads in order of assigned priority, from lowest to highest priority, until the predicted demand falls below the target. Visually verify system displays change of status signals for equipment that is shutdown.

TEST NO: Factory-51 Page 2 of 2
TITLE: Demand Limiting Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that sheds electrical loads for peak demand control using prediction techniques to avoid exceeding preestablished peak demand values.

EVENT	EXPECTED RESULTS
3. Program demand levels to fall below target limit such that some, but not all loads, are restored. Assign equipment constraints to some equipment in the DE so that the units cannot be shed at the time the next demand target is exceeded.	3. System begins to restore shed equipment. Verify the points representing the highest priority shed are restored before units of lower priority. Verify units with equipment constraints assigned in event (3) are not shed.
4. Decrease target and inhibit the "end-of interval" signal from the system so that demand is computed by the "sliding window" method.	4. System initiates load shed on units with the lowest priority that are still operating as in result (2). Verify units with equipment constraints assigned to Event (3) are not shed. System displays change of status for equipment that is restored to the system.
5. Change the target in the demand limiting program operation from sliding window to time of day metering.	5. System executes demand limiting program for time of day metering.
6. Repeat events (2) through (4) above for each time of day target. Each time of day program has ____ different priority levels and targets.	6. System initiates control on points representing loads as per results (2) through (4) for each of the different priority levels, for each time of the day target.

TEST NO: Factory-52 Page 1 of 4
TITLE: Day-Night Setback Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that reduces the heating space temperature setpoint during unoccupied hours or raises the cooling space temperature setpoint during unoccupied hours.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of equipment used in the day-night setback program.
2. The contractor provides specific data for each required input and provides the predicted output with an explanation of how the output is determined.
4. Equipment operation coincides with the test period.
5. Program specified points to represent the status of outside air dampers and space temperatures.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions causing heating equipment to be in the night setback mode: . Winter season. . Unoccupied period. . Interior space temperatures requiring heating. Command the system to display equipment status, damper position, and space temperatures.	2. Verify displayed status of equipment operation and space temperatures match predicted results. Verify system displays status of outside air dampers to be closed.

TEST NO: Factory-52 Page 2 of 4
TITLE: Day-Night Setback Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that reduces the heating space temperature setpoint during unoccupied hours or raises the cooling space temperature setpoint during unoccupied hours.

EVENT	EXPECTED RESULTS
3. Initiate conditions causing heating equipment to be in the daytime mode of operation: . Winter season. . Occupied time period. . Interior space temperatures requiring heating. Command the system to display equipment status and space temperatures.	3. Verify displayed status of equipment operation and space temperatures match predicted results (equipment is started, outside air dampers are placed under local control, and space temperatures increased to occupied setpoints).
4. Command the system to modify day-night setback program.	4. System requests equipment identification and input.
5. Enter equipment identification and new input (for example, modify minimum occupied temperature). Command the system to place equipment with new input in the occupied mode.	5. System acknowledges input and executes program in accordance with modified input. Selected equipment operation follows new program inputs.
6. Initiate conditions causing heating equipment to be in the night setback mode: . Heating season. . Unoccupied period. . Interior space temperatures requiring heating. Command the system to display equipment status, damper position, and space temperatures.	6. Verify displayed status of equipment operation and space temperatures match predicted results. Verify system displays status of outside air dampers to be closed.

TEST NO: Factory-52 Page 3 of 4
TITLE: Day-Night Setback Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that reduces the heating space temperature setpoint during unoccupied hours or raises the cooling space temperature setpoint during unoccupied hours.

EVENT	EXPECTED RESULTS
7. Initiate conditions which will cause night setback for cooling equipment. . In summer operation. . Occupied time period. . Interior space temperatures requiring cooling. Command the system to display equipment status, ouside air damper position and space temperature.	7. Verify displayed status of equipment matches predicted results (equipment is started, outside air dampers are placed under local control, and space temperatures are decreased to occupied setpoints).
8. Initiate conditions causing cooling equipment to be in daytime mode of operation: . In summer operation. . Occupied time period. . Interior space temperatures requiring cooling. Command the system to display equipment status, outside air damper position, and space temperature.	8. Visually verify equipment is started, outside air dampers are placed under local mode control, and space temperatures are decreased to occupied period levels. Verify displayed status of equipment matches predicted results.
9. Command the system to modify day-night setback program.	9. System requests equipment identification and input.
10. Enter equipment identification and new input (for example, modify occupied temperature). Place equipment with new input in the unoccupied mode.	10. System acknowledges input and executes program in accordance with modified input. Verify selected equipment operation follows new program inputs.

TEST NO: Factory-52 Page 4 of 4
TITLE: Day-Night Setback Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that reduces the heating space temperature setpoint during unoccupied hours or raises the cooling space temperature setpoint during unoccupied hours.

EVENT	EXPECTED RESULTS
11. Initiate conditions which will cause night setback for cooling equipment. . In summer operation. . Occupied time period. . Interior space temperatures requiring cooling. Command the system to display equipment status, ouside air damper position and space temperature.	11. Verify displayed status of equipment matches predicted results (equipment is started, outside air dampers are placed under local control, and space temperatures are decreased to occupied setpoints).

TEST NO: Factory-53 Page 1 of 1
TITLE: Economizer Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that reduces HVAC System cooling requirements when the outside air (OA) dry bulb temperature is less than the required mixed air temperature of HVAC System.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status equipment included in the economizer program.

2. The contractor provides an explanation of how OA dampers are affected by OA dry bulb, return air (RA) dry bulb, and the changeover temperature. The contractor also provides at least 2 different predicted positions of outside air dampers (fully open, under local loop control) based on based on 2 different sets of input values on outside air and return air dry bulb temperatures.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions which will cause outside air (OA) dampers to be fully closed or in minimum position (for example, when OA dry bulb is greater than the specified changeover temperature).	2. System commands OA damper to be in closed or minimum position. Verify system display of status of OA dampers agrees with predicted results.
3. Initiate conditions which will cause outside air (OA) dampers to be under local control (for example, when OA dry bulb is less than the specified changeover temperature and return air temperature).	3. System commands outside air dampers to be under local loop control to maintain mixed air temperature status of the OA dampers (open). Visually verify point output on damper position agrees with predicted results.
4. Modify changeover temperature setpoint and repeat events (2) and (3).	4. System commands OA as in (2) and (3) at the new changeover temperature.

TEST NO: Factory-54 Page 1 of 1
TITLE: Enthalpy Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that reduces HVAC system cooling requirements when the enthalpy of the outside air (OA) is less than that of the return air.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of equipment included in the economizer program.

2. The contractor provides an explanation of how OA dampers are affected by OA, and also provides at least 2 different predicted positions of outside air dampers (fully open, under local loop control) based on 2 different sets of input values on outside air and return air enthalpy conditions.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions which will cause outside air (OA) dampers to be at minimum position (example - when OA enthalpy exceeds return air enthalpy).	2. System commands OA dampers to be closed. Verify system display of status of OA dampers agrees with predicted results.
3. Initiate conditions which will cause outside air (OA) dampers to be under local loop control (example - when OA enthalpy is less than return air enthalpy).	3. Outside air dampers are placed under local loop control. Verify system display of status of OA dampers agrees with predicted results.

TEST NO: Factory-55 Page 1 of 2
TITLE: Ventilation - Recirculation Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that reduces the HVAC system thermal load during warm-up or cool-down cycles prior to occupancy of the building.

INITIAL CONDITIONS

1. Specified points in the DE indicate the status of equipment used in the ventilation - recirculation program.
2. The system is programmed to execute the ventilation - recirculation program.
3. The contractor provides an explanation of how OA temperature, RA temperature and space temperature effect heating cooling equipment operation. The contractor also provides a set of conditions which will cause predictable equipment operation based on specified input values used during the test period.
4. Simulated OA dampers and relief dampers are set up to change position during occupied periods.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions causing a warm-up cycle during an unoccupied cycle prior to occupancy: . Winter season. . Unoccupied period. . OA temperature is below required occupied space temperature.	2. Visually verify OA dampers remain closed when HVAC equipment is started. Verify system displays the status of the dampers to be closed and fans to be on.

TEST NO: Factory-55 Page 2 of 2
TITLE: Ventilation - Recirculation Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that reduces the HVAC system thermal load during warm-up or cool-down cycles prior to occupancy of the building.

EVENT	EXPECTED RESULTS
3. Initiate conditions causing occupied space temperature to reach desired levels prior to occupancy time. . Cooling season. . Unoccupied period. . OA temperature is below occupied space temperature.	3. Verify OA air dampers and HVAC equipment . Winter are placed under local loop control. Verify system displays status of dampers to be under local loop control.
4. Initiate conditions causing a cool-down cycle during period prior to occupied period: . Cooling season. . Unoccupied period. . OA temperature is above required occupied space temperature.	4. Verify OA air dampers are closed and HVAC equipment is started. Verify system displays status of OA relief air dampers to be closed and status of fans on.
5. Initiate conditions that will require the OA damper to be placed under local loop control during the period prior to the occupied time. . Winter season. . Unoccupied period. . OA temperature is above occupied space temperature.	5. Verify OA dampers and HVAC equipment are placed under local loop control. Verify system display status of dampers to be under local loop control.

TEST NO: Factory-56 Page 1 of 2
TITLE: Hot Deck - Cold Deck Temperature Reset Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that resets the hot deck - cold deck temperatures in dual duct and multizone HVAC systems to minimize the temperature differential between the hot and cold deck temperature.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of equipment included in the hot deck - cold deck program.
2. The system is programmed to execute the hot deck - cold deck temperature reset program.
3. The contractor provides an explanation of how space temperature and humidity requirements affect hot deck - cold deck temperature reset. The contractor also provides the test input data with expected zone hot and cold deck temperatures.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate an increase in space temperature dry bulb setpoints for each zone so that the hot deck and cold deck temperature reset is required. Command the system to display hot deck and cold deck temperatures.	2. System executes the hot and cold deck temperature reset program to maintain zone space dry bulb setpoints. Visually verify hot deck and cold deck discharge temperatures are reset upwards in accordance with expected results.
3. Initiate a change in space dry bulb temperature downwards for each zone so that hot and cold deck temperature reset is required. Command the system to display hot deck and cold deck temperatures.	3. Visually verify hot deck and cold deck discharge temperatures decrease in accordance with expected results.
4. Initiate an increase in space dry bulb temperature and humidity setpoints for the zone with the maximum heating requirements.	4. Visually verify hot deck temperature is reset upwards in accordance with expected results. Visually verify cold deck temperature is not reset.

TEST NO:	Factory-56 Page 2 of 2
TITLE:	Hot Deck - Cold Deck Temperature Reset Program
APPLIES TO:	Large, Medium and Small EMCS
REFERENCE:	Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that resets the hot deck - cold deck temperatures in dual duct and multizone HVAC systems to minimize the temperature differential between the hot and cold deck temperature.

EVENT	EXPECTED RESULTS
5. Initiate a decrease in space dry bulb and humidity setpoints for the zone with the maximum cooling requirements.	5. Visually verify cold deck temperature is reset downwards in accordance with expected results. Visually verify hot deck temperature is not reset.

TEST NO: Factory-57 Page 1 of 2
TITLE: Reheat Coil Reset Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that selects the zone that requires the least amount of reheat and resets the cold deck discharge temperature to equal the discharge temperature of the zone with the lowest reheat demand.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of equipment included in the reheat coil reset program.
2. The contractor provides an explanation of how the zone temperature and humidity requirements affect the cold deck discharge temperatures.
3. The contractor provides input data on zone temperatures and humidity requirements with expected cold deck discharge temperatures for the test.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate dry bulb setpoints in all zones to be above initial cold deck discharge temperature setpoint so that reheat is required in all zones.	2. System executes the reheat coil discharge program to reset cold deck discharge temperature upwards until a reheat coil in the zone with lowest space temperature setpoint is fully closed. In other zones with higher reheat requirements, reheat coil valves are partially open.
3. Initiate a change in the space temperature setpoint upwards for the zone with the reheat coil that is fully closed, so that the setpoint is higher than all other zones. Command the system to display equipment status.	3. Verify that the cold deck discharge is further increased until the reheat coil valve for the zone with the current lowest space temperature setpoint is fully closed. Visually verify sequence of equipment operation, and verify system display of final status agrees with predicted results.

TEST NO: Factory-57 Page 2 of 2
TITLE: Reheat Coil Reset Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that selects the zone that requires the least amount of reheat and resets the cold deck discharge temperature to equal the discharge temperature of the zone with the lowest reheat demand.

EVENT	EXPECTED RESULTS
4. Initiate a change in the space temperature setpoint downwards to the zone with the reheat coil that is fully closed so that the setpoint is below all other zones. Command the system to display equipment status.	4. Verify that the cold deck discharge is reduced until the cold deck discharge temperature equals the discharge temperature of the zone with the lowest reheat demand. Visually verify sequence of equipment operation, and verify system display of final status agrees with predicted results.
5. Repeat events (2) (3) and (4) with dry bulb and humidity setpoints. Command the system to display equipment status.	5. Visually verify that the cold deck reset program resets the cold deck discharge until the zone(s) with the highest reheat demand is satisfied. Visually verify that reheat valve for the zone(s) with the lowest reheat demand is fully closed. Verify system display of final status agrees with predicted results.

TEST NO: Factory-58 Page 1 of 2
TITLE: Steam Boiler Optimization Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that selects the most efficient boiler(s) based on boiler data to satisfy the heating load.

INITIAL CONDITIONS

1. Selected points in the DE indicate boiler status and operating efficiency.
2. The contractor provides an explanation of how the program optimizes boiler plant operation to meet at least three levels of heating demand (low, average, maximum) representative of the size of boilers installed. The contractor also provides input data for establishing heating demand, such as OA temperature trends, and indicates the sequence and timing of boiler operation to satisfy various demands.
3. Boilers are to be either shutdown or at minimum load at the beginning of the test.
4. The system is programmed to execute the steam boiler plant optimization program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions for minimum heating requirements. Command the system to display boiler status and operating efficiency.	2. System executes steam water boiler optimization program for minimum heating requirements using the available boilers. The boilers that most efficiently satisfy minimum heating requirements are started-up or loaded. Visually verify system display of status on boilers and operating efficiency agrees with predicted results.
3. Input a revised set of analog values that establish a trend towards higher, but not maximum, steam output requirements, requiring multiple boiler operation. Command the system to display boiler status and operating efficiency.	3. Boilers that most efficiently satisfy higher heating requirements are started up and/or loaded. Verify the system display of status on boilers and operating efficiency corresponds with predicted results.

TEST NO: Factory-58 Page 2 of 2
TITLE: Steam Boiler Optimization Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that selects the most efficient boiler(s) based on boiler data to satisfy the heating load.

EVENT	EXPECTED RESULTS
4. Input revised analog values that show a trend towards maximum steam output requirements.	4. Boilers that most efficiently satisfy maximum heating requirements are started up and/or loaded. Verify system display of status on boilers and operating efficiency corresponds with predicted results.
5. Input analog values that predict lower steam plant output.	5. Verify system display of status on boiler and operating efficiency corresponds with predicted results.

TEST NO: Factory-59 Page 1 of 2
TITLE: Hot Water Boiler Optimization Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that select the most efficient boiler(s) based on boiler operating data to satisfy the heating load.

INITIAL CONDITIONS

1. Selected points in the DE indicate boiler status and operating efficiency.
2. The contractor provides an explanation of how the program optimizes boiler plant operation to meet at least three levels of heating demand (low, average, maximum) representative of the size of boilers installed. The contractor also provides input data for establishing heating demand, such as OA temperature trends, and indicates the sequence and timing of boiler operation to satisfy various demands.
3. Boilers are to be either shutdown or at minimum load at the beginning of the test.
4. The system is programmed to execute the hot water boiler plant optimization program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions for minimum heating requirements. Command the system to display boiler status and operating efficiency.	2. System executes hot water boiler optimization program for minimum heating requirements using the available boilers. The boilers that most efficiently satisfy minimum heating requirements are started-up and/or loaded. Visually verify system display of status on boilers and operating efficiency agrees with predicted results.
3. Input a revised set of analog values that establish a trend towards higher hot water output requirements, requiring multiple boiler operation. Command the system to display boiler status and operating efficiency.	3. Boilers that most efficiently satisfy higher heating requirements are started up and/or loaded. Verify the system display of status on boilers and operating efficiency corresponds with predicted results.

TEST NO: Factory-59 Page 2 of 2
TITLE: Hot Water Boiler Optimization Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that select the most efficient boiler(s) based on boiler operating data to satisfy the heating load.

EVENT	EXPECTED RESULTS
4. Input revised analog values that show a trend towards maximum hot water output requirements.	4. Boilers that most efficiently satisfy maximum heating requirements are started up and/or loaded. Verify system display of status on boilers and operating efficiency corresponds with predicted results.
5. Input analog values that predict lower steam plant output.	5. Verify system display of status on boiler and operating efficiency corresponds with predicted results.

TEST NO: Factory-60 Page 1 of 1
TITLE: Hot Water OA Reset Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that resets the hot water temperature supplied by the boiler or converter in accordance with the outside air (OA) temperature.

INITIAL CONDITIONS

1. Specified points in the DE indicate the status of equipment used in the hot water OA reset program.
2. The contractor provides an explanation of how the outside air temperature affects the hot water supply temperature. The contractor also provides input data on outside air temperatures with corresponding expected hot water supply temperature.
3. The system is programmed to execute the hot water OA reset program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions causing reduction and increases in the outside air temperature. Command the system to display hot water supply temperature setpoint and outside air temperature for different OA temperatures.	2. System executes the hot water OA reset program which calculates hot water reset temperature in accordance with reset schedule. Verify system display of hot water supply temperature setpoint in the corresponding OA temperature agrees with predicted results.
3. Initiate condition causing minimum and maximum OA conditions.	3. System executes the OA reset program. Verify system display for maximum and minimum hot water temperature match those in the reset schedule.
4. Change OA reset schedule and repeat events (2) and (3).	4. Verify that the results correspond to results (2) and (3).

TEST NO: Factory-61 Page 1 of 2
TITLE: Chiller Optimization Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that selects the most efficient chiller(s) based on chiller operating profile data to satisfy the cooling load using prediction techniques to match chiller capacity with the predicted load.

INITIAL CONDITIONS

1. Selected points in the DE indicate chiller status, chilled water pump status and condenser water pump operation.

2. The contractor provides an explanation of how the program optimizes chiller plant operation to meet at least three levels of cooling demand (low, average, maximum) representative of the size of chiller controlled. The contractor provides input data for establishing cooling demand; such as OA temperature trends and indicates the sequence and timing of chiller operation to satisfy various demands, including lag time for chiller response to change in cooling demand.

3. The chiller(s) are set up to be either shut down or at a minimum load at the beginning of the test.

4. The system is programmed to execute the chiller plant optimization program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions causing a demand for minimum cooling requirements. Command the system to display status of chillers, chilled water and condenser water pumps.	2. System executes the chilled water optimization program for minimum cooling requirements of the available chillers. The chillers that most efficiently satisfy minimum cooling requirements are started-up. Verify system display of status on chillers and pumps agrees with predicted results. Verify the chiller(s) are started up in accordance with the chiller manufacturer's startup sequence requirements.

TEST NO: Factory-61 Page 2 of 2
TITLE: Chiller Optimization Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that selects the most efficient chiller(s) based on chiller operating profile data to satisfy the cooling load using prediction techniques to match chiller capacity with the predicted load.

EVENT	EXPECTED RESULTS
3. Input a revised set of analog values that establish a trend towards higher chilled water plant output requirements.	3. Chillers that most efficiently satisfy higher cooling requirements are started up and/or loaded to meet the expected load. Verify system display of status on chillers and pumps agrees with predicted results. Verify the chiller(s) are started up in accordance with the chiller manufacturer's startup sequence requirements.
4. Input analog values that show a trend towards maximum chilled water plant output requirements. Command the system to display chiller and associated pump status.	4. Chillers that most efficiently satisfy maximum cooling requirements are started up and/or loaded to meet the expected load. Verify system display of status on chillers and pumps agrees with predicted results. Verify the chiller(s) are started up in accordance with the chiller manufacturer's startup sequence requirements. Verify there is a predetermined time lag between initiation of cooling demand requiring full load operation and initiation of full load operation at the chiller.
5. Input analog values that predict lower chilled water plant output. Command the system to display chiller and associated pump status.	5. Verify system display of status on chillers and pumps agree with predicted results. If chiller(s) are shutdown, verify shutdown procedure is in accordance with the chiller manufacturer's requirements
6. Input analog values that predict minimum chilled water plant output. Command the system to display chiller and associated pump status.	6. Verify system display of status on chillers and pumps agree with predicted results. If chiller(s) are shutdown, verify shutdown procedure is in accordance with the chiller manufacturer's requirements.

TEST NO: Factory-62 Page 1 of 1
TITLE: Chiller Water Temperature Reset Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that resets the chilled water temperature supplied by water chiller in accordance with space temperature and humidity requirements.

INITIAL CONDITIONS

1. Selected points in the DE indicate chiller water temperatures, dry bulb temperature, and relative humidity of spaces included in the test.
2. The contractor provides an explanation of how space temperature/humidity requirements affect chilled water temperatures. The contractor also provides input data on space temperature and humidity requirements with corresponding expected chilled water supply temperatures.
3. The system is programmed to execute the chiller water temperature reset program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/ outputs.
2. Initiate decreases in the zones space temperature and relative humidity setpoints that require the lowest chilled water supply temperature. Command the system to display chilled water supply temperature.	2. System executes the chiller water reset program. The chilled water supply temperature is reset to the minimum level. Verify the system display of chilled water temperature agrees with predicted results.
3. Initiate increases in zone space relative humidity and space temperature setpoints. Command the system to display chilled water supply temperature.	3. Chilled water temperature is reset upwards to satisfy new space temperature and relative humidity setpoints. Verify system display of chilled water temperature agrees with predicted results.
4. Initiate an increase in all space temperature and humidity setpoints that require the maximum chilled water supply temperatures. Command the system to display chilled water supply temperature.	4. Chilled water supply is reset to its maximum value. Verify system display of chilled water temperature agrees with predicted results.

TEST NO: Factory-63 Page 1 of 1
TITLE: *Condenser* Water Temperature Reset Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that resets the operating chiller condenser water temperature from a fixed temperature downward when the OA wet bulb temperature will produce a lower condenser water temperature.

INITIAL CONDITIONS

1. Selected points in the DE indicate condenser water temperatures and outside air wet bulb temperatures.
2. The contractor provides an explanation of how changes in OA wet bulb affect condenser water temperatures. The contractor also provides input data on OA wet bulb with corresponding condenser water temperature levels.
3. The system is programmed to execute the condenser water temperature reset program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate OA wet bulb to fall below condenser water temperature. Command the system to display the condenser water temperature.	2. System executes the condenser water supply temperature reset program. The program compares OA wet bulb with condenser water supply temperature. The condenser water controller setpoint is reset downwards to match OA wet bulb temperature. Verify system display of condenser water temperature matches predicted results.
3. Initiate OA wet bulb to fall below the minimum allowable condenser water temperature.	3. Program resets condenser water controller setpoint to a minimum allowable value and no lower. Verify the system display of condenser water temperature agrees with predicted results.

TEST NO: Factory-64 Page 1 of 2
TITLE: Chiller Demand Limit Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that limits the maximum available chiller capacity when commanded by the demand limiting program.

INITIAL CONDITIONS

1. Selected points in the DE indicate chiller status.
2. The system is programmed to execute the chiller demand limit program.
3. The contractor assigns each step of chiller capacity control to a different priority level of the demand limit program (for example, assign lowest priority to first step below full capacity and highest priority to minimum load). The chiller cooling capacity is set at maximum.
4. The contractor provides an explanation of how the chiller demand limit program fixed steps of chiller capacity control are interfaced with the demand limiting program for each assigned priority level.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate conditions causing the system to execute the chiller demand limit program (for example, cause demand to exceed peak demand target).	2. Verify the maximum cooling capacity of chiller is reduced to the preassigned fixed step. Verify system display of status of available chiller capacity agrees with predicted results.

TEST NO: Factory-64 Page 2 of 2
TITLE: Chiller Demand Limit Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that limits the maximum available chiller capacity when commanded by the demand limiting program.

EVENT	EXPECTED RESULTS
3. Initiate conditions causing the highest demand limit priority step of chiller fixed capacity to be activated (for example, continue to increase demand until highest priority step of chiller fixed capacity is shed).	3. Verify that the available maximum cooling capacity is reduced for each additional fixed step reduction.
4. Initiate conditions causing chiller fixed capacity to be restored on-line when the demand is reduced.	4. Verify the maximum cooling capacity of the total system is restored. Verify system display of status of available chiller capacity agrees with predicted results.

TEST NO: Factory-65 Page 1 of 1
TITLE: Lighting Control Program
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate software that turns equipment on and off based on the time of day and the day of week, including holidays.

INITIAL CONDITIONS

1. Selected points in the DE indicate the status of lighting control systems.
2. The test period includes time periods that correspond to each unique lighting schedule.
3. Establish an initial status on all systems (example - off).
4. The system is programmed to execute the lighting control program.

EVENT	EXPECTED RESULTS
1. Compare list of program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied program inputs/outputs include those inputs/outputs in the contract documents. Contractor program can include other inputs/outputs.
2. Initiate a time period for lights to be turned on and off. Command the system to display status of lighting systems.	2. System executes lighting control program. Lighting systems start up and shut down in accordance with the equipment schedule. Verify system display of status of each lighting system (on or off) corresponds to predicted results.
3. Manually disable selected points to simulate the activity of turning off lights locally.	3. System displays alarms for each simulated lighting system locally turned off.

TEST NO: Factory-66 Page 1 of 1
TITLE: System Spare Memory Verification
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that the CCU spare memory was not utilized for systems operation or utility programs.

INITIAL CONDITIONS

1. All EMCS software for systems operation and utility programs have been tested.
2. Non-EMCS task(s) have been loaded on system spare memory such that system spare memory is fully loaded throughout the factory test.

EVENT	EXPECTED RESULTS
1. Command the system to display the status of the non-EMCS task loaded during system startup.	1. System displays the status of the non-EMCS task(s), which corresponds with expected results.

TEST NO: Factory-67 Page 1 of 1
TITLE: Custom Programs
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate custom program software performs in accordance with the contract requirements.

INITIAL CONDITIONS

1. The contractor provides an explanation of each program, provides necessary input data for each program and indicates the expected results.

EVENT	EXPECTED RESULTS
1. Compare list of each custom program inputs and outputs required in the contract documents against the contractor supplied input/output.	1. Contractor supplied programs inputs/outputs include those inputs/outputs in the contract documents. Contractor programs can include other inputs/outputs.
2. Command the system to execute each custom program.	2. Verify program output corresponds with expected results.

TEST NO: Factory-68 Page 1 of 2
TITLE: CCU Program Development
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the program development facility which allows the development and debugging of control programs while running EMCS programs in the on-line mode.

INITIAL CONDITIONS

1. The contractor provides a source program written in a FORTRAN or PASCAL type language with known errors that perform a verifiable operation in the DE. (For example, provide a program that starts and stops equipment based on time and indoor/outdoor temperatures). The contractor also provides input data and expected results.
2. The system is performing on-line monitoring and control functions throughout the test.
3. Operator is logged onto system at a level that enables operator access to the custom programming capabilities.

EVENT	EXPECTED RESULTS
1. Enter source program with name of file via the editor. (This program will be called the test program hereafter.) Command the system to generate hard copy output.	1. CCU loads and compiles program into object code. Verify a hard copy listing matches contractor supplied listing, and that system displays error messages on known errors.
2. Correct errors via the editor program. Command the system to generate hard copy output.	2. CCU loads and compiles corrected program. Verify hard copy printout corresponds to contractor supplied document without errors.
3. Command the system to save the test program on designated disk file.	3. CCU saves test program on disk file.
4. Initiate the debugging software to check program logic. Check output of program against expected results using FID test set and its associated DE.	4. System provides necessary information for the operator to follow, line by line, the execution of the program. Verify program output agrees with expected results using the FID test set.

*Large/Medium EMCS

TEST NO: Factory-68 Page 2 of 2
TITLE: CCU Program Development
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the operation of the program development facility which allows the development and debugging of control programs while running EMCS programs in the on-line mode.

EVENT	EXPECTED RESULTS
5. Command the system to actuate the program in the CCU using a FID/MUX*/IMUX and its associated DE.	5. System transfers the program to the CCU on-line mode status using a FID/MUX*/IMUX.
6. Command the system to display the directory programs active in the CCU.	6. Verify system display of active programs includes the test program.

*Large/Medium EMCS

TEST NO: Factory-69 Page 1 of 2
TITLE: FID Software Programming
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the programming function in the CCU to write or modify programs for execution in the FID.

INITIAL CONDITIONS

1. The contractor provides a source program with a known error that performs a visually verifiable operation in the DE. (For example, provide a program that starts or stops equipment based on time and indoor/outdoor temperatures). The contractor also provides input data and expected results.
2. The system is performing on-line monitoring and control functions throughout the test.
3. Operator is logged onto system at a level that enables operator access to FID software programming.

EVENT	EXPECTED RESULTS
1. Enter source program with name of file via the editor (this program will be called the test program hereafter). Command the system to generate hard copy output.	1. CCU loads and compiles program into object code. Verify a hard copy listing matches contractor supplied listing, and that system displays error messages on known errors.
2. Correct errors via the editor program. Command the system to generate hard copy output.	2. CCU loads and compiles corrected program. Verify hard copy printout corresponds to contractor supplied document without errors.
3. Command the system to save the test program on designated disk file.	3. CCU saves test program on disk file.
4. Command the system to transfer software to the designated PROM programmer or alternately download FID RAM based software from the CCU to the FID test set.	4. System transfers the FID RAM based software from the CCU to the FID test set or PROMS are installed in the FID test set.
5. Initiate the debugging software to check program logic. Check output of program against expected results using FID test set.	5. System provides necessary information for the operator to follow, line by line, the execution of the program. Verify program output agrees with expected results.

TEST NO: Factory-69 Page 2 of 2
TITLE: FID Software Programming
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the programming function in the CCU to write or modify programs for execution in the FID.

EVENT	EXPECTED RESULTS
6. Command the system to list and store the object code generated for the debugged program.	6. System generates a hard copy listing of the test program and stores program on disk.
7. Command the system to download software to selected FID or command the system to create a new PROM.	7. System downloads software to selected FID or PROM and software installed in the selected FID.
8. Command the system to start execution of software at a selected FID using the local DE at a designated time.	8. Visually verify FID correctly executes program software with the DE points assigned to the program.

TEST NO: Factory-70 Page 1 of 2
TITLE: Algorithmic Control Sequences
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that permits the creation and execution of algorithmic control sequences for automated control of equipment based on operational parameters, including those defined in the data base.

INITIAL CONDITIONS

1. The contractor provides an algorithmic control sequence with at least ____ terms and known errors that utilize the mathematics package functions stored in the system. The contractor also provides input values for the control sequences with appropriate output.
2. The contractor indicates total storage allocated for algorithmic control sequences and method of storage.
3. The system contains ____ algorithmic control sequences, each with ____ terms. Contractor provides list of sequences stored, the number of terms in each sequence, and the amount of storage allocated to the sequence.
4. The system is performing on-line monitoring and control functions throughout the test.
5. Operator is logged onto system at a level that enables operator access to algorithmic control sequences.

EVENT	EXPECTED RESULTS
1. Enter the algorithmic control sequence via the designated terminal.	1. CCU loads and compiles program. System generates a hard copy listing with error messages.
2. Correct error via editor program. Verify hard copy output against contractor supplied document.	2. CCU loads and complies corrected program. System generates a hard copy listing.
3. Command the system to save the test program.	3. CCU saves test program.
4. Command the system to execute test sequence using FID test set.	4. System executes sequence and displays output in the FID test set. Verify output against predicted results.
5. Command the system to protect the test sequence.	5. System acknowledges command.
6. Command the system to delete the protected algorithmic control sequence.	6. System indicates command cannot be executed because algorithmic control sequence is protected.

TEST NO: Factory-70 Page 2 of 2
TITLE: Algorithmic Control Sequences
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that permits the creation and execution of algorithmic control sequences for automated control of equipment based on operational parameters, including those defined in the data base.

EVENT	EXPECTED RESULTS
7. Command the system to modify protected algorithmic control sequence.	7. System indicates command cannot be executed because algorithmic control sequence is protected.
8. Command the system to remove protection from test sequence.	8. System executes command.
9. Command the system to change the sequence.	9. System requests modification.
10. Enter modification. Command the system to print out new sequence.	10. CCU loads and compiles program with modification. Verify the hard copy listing contains the modifications.
11. Command the system to delete test algorithmic sequence.	11. System executes command.
12. Command the system to execute test sequence.	12. System indicates command cannot be executed because the sequence does not exist.
13. Command the system to display the storage space allocated for all algorithmic control sequences stored in the system.	13. System displays the storage space. Verify sufficient storage is allocated by using the contractors method of storing algorithmic control sequences to determine storage space required.

TEST NO: Factory-71 Page 1 of 2
TITLE: Backup Mode for CCU Failure
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that detects failure of the CCU causing the CCC to begin backup operation of the EMCS in a reduced mode.

INITIAL CONDITIONS

1. Selected points in the DE are set up to initiate alarms during the test and to indicate the status of equipment to be used in the power demand limiting function.
2. The contractor provides the list of operator's commands similar and consistent with the CCU commands, and available to the operator during CCU failure. The contractor provides an explanation of each operator command, including expected system response to the command.
3. The electrical demand is set up to exceed allowed limits for peak demand.
4. The contractor provides a description of power demand limiting functions.
5. The system is programmed to execute the power demand limiting function.

EVENT	EXPECTED RESULTS
1. Initiate a CCU failure.	1. The system controller automatically switches the logging and alarm printers to the CCC.
2. Initiate DE alarms.	2. The CCC takes over alarm reporting functions of the CCU using the alarm printer.
3. Command the system to display the list of available operator's commands from the CCC during the CCU power failure.	3. Verify displayed list corresponds to contractor's list.
4. Command the system to perform each of the operator's commands listed by the system, including:	4. Verify system responds to each operator command in accordance with responses provided by the contractor, including:

TEST NO: Factory-71 Page 2 of 2
TITLE: Backup Mode for CCU Failure
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that detects failure of the CCU causing the CCC to begin backup operation of the EMCS in a reduced mode.

EVENT	EXPECTED RESULTS
(a) Command for status of specified points.	(a) System displays point status.
(b) Command the system to display the parameters of specific points.	(b) System displays point identification and associated parameters.
(c) Command the system to change specified point parameter(s) and input the new parameters.	(c) System acknowledges input.
(d) Command the system to display the modified parameters of the points.	(d) System displays point identification and associated parameters, including those which were modified.
(e) Command the system to control analog and digital output points.	(e) Visually verify execution of commands.
5. Initiate conditions for peak demand reduction. Command the system to display equipment status.	5. System executes demand reduction program and causes equipment to be controlled in accordance with the power demand limiting function sequence. System displays equipment status that corresponds to shutdown requirements for power demand limiting function. Verify equipment status corresponds to predicted results.

TEST NO: Factory-72 Page 1 of 2
TITLE: Backup Mode for CCC Failure
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the failover controller to automatically switch all CLT data lines from the CCC to the CCU during CCC failure.

INITIAL CONDITIONS

1. DE analog and digital points are selected for the test.

TEST EQUIPMENT

1. Stopwatch with an accuracy of 0.1 seconds.

EVENT	EXPECTED RESULTS
1. Initiate CCC failure.	1. Failover controller automatically switches all CLT lines to the CCU. Verify failover controller indicates CCC failure and system reports CCC failure.
2. Initiate analog and digital alarm conditions for selected points in the DE under normal heavy load conditions.	2. Verify the system commences to display alarms at the operator's console within 20 seconds of command entry.
3. Command a change of status in selected analog and digital points in the DE.	3. Verify the system commences to process operator command within 10 seconds of command entry. Verify the system commences to execute the change of status within 20 seconds from command entry. Verify the time delay between the command entry and the initiation of display of status change at the operator's console is within 40 seconds, plus response time for the control device.

TEST NO: Factory-72 Page 2 of 2
TITLE: Backup Mode for CCC Failure
APPLIES TO: Large
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the failover controller to automatically switch all CLT data lines from the CCC to the CCU during CCC failure.

EVENT	EXPECTED RESULTS
4. Command the system to execute each of the following: . Initiate reports. . Request graphic displays. . Modify time and event scheduling. . Modify analog limits. . Adjust setpoints of selected controllers. . Select manual or automatic control modes. . Enable and disable individual points; disabling shall take precedence over all other actions. . Enable and disable individual FID. . Enable and disable individual MUX or IMUX panels. . Point definition.	4. Visually verify system commences to process operator commands within ten seconds of command entry. Verify all commands are executed.
5. Place CCC back in service.	5. Verify the failover controller does not switch CLT lines back to CCC.
6. Manually activate failover controller transfer of CLT lines back to CCC.	6. Verify the CLT lines are transferred.
7. Initiate alarm conditions for selected points in the DE.	7. Verify the system commences to display alarms at the operator's console within 10 seconds of command entry.
8. Command a change of status in selected analog and digital points in the DE.	8. Verify the system commences to process operator command within 5 seconds of command entry. Verify the system commences to execute the change of status within 10 seconds from command entry. Verify the time delay between the command entry and the initiation of display of status change at the operator's console is within 20 seconds, plus response time for the control device.

TEST NO: Factory-73 Page 1 of 1
TITLE: Backup to Disk Storage System Failure
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate performance of the duplicate disk system in the event of primary disk system failure.

INITIAL CONDITIONS

1. Selected points in the DE are set up to change status during the test period.

EVENT	EXPECTED RESULTS
1. Initiate a failure in the primary disk system.	1. System will not respond to any commands.
2. Bring the second disk system "on-line" by use of the programmer's panel or a pre-programmed bootstrap routine. Institute change of status for selected DE points.	2. System updates the data base automatically within 15 minutes after placing the backup disk system on line.
3. Within fifteen minutes after second disk is brought on line, command the system to display the status of the selected points in DE that changed status during the disk failure.	3. Verify that the system display of selected point status corresponds to the DE status.

TEST NO: Factory-74 Page 1 of 2
TITLE: Printer Failure Mode
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that all output normally directed to the logging printer can be redirected to the alarm printer and all output manually directed to the alarm printer can be redirected to the logging printer.

INITIAL CONDITIONS

1. Contractor provides necessary input for system to generate a periodic automatic report.

EVENT	EXPECTED RESULTS
1. Command the system to generate a periodic automatic report. (For example, request a status report.)	1. System requests time of initial report, time interval between reports, and output peripheral.
2. Specify initial time to be current time. Specify time interval to be sufficiently short so that at least four periodic automatic reports are generated during the test. Specify output peripheral to be the logging printer.	2. Visually verify the first periodic automatic report is generated on the logging printer.
3. Turn off the logging printer after the first periodic automatic report is generated. Command the system to print the periodic automatic report on the alarm printer.	3. Verify the next periodic automatic report is not printed on the logging printer at the expected time. Verify system prints the second periodic automatic report on the alarm printer.
4. Initiate DE alarms.	4. Visually verify that alarms are printed on the alarm printer.

TEST NO: Factory-74 Page 2 of 2
TITLE: Printer Failure Mode
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate that all output normally directed to the logging printer can be redirected to the alarm printer and all output manually directed to the alarm printer can be redirected to the logging printer.

EVENT	EXPECTED RESULTS
5. Return power to logging printer before the third periodic automatic report is to be printed. Command the system to print the periodic automatic report on the logging printer.	5. System prints the third periodic automatic report on the logging printer. Alarm messages continue to be printed on the alarm printer.
6. Turn off the alarm printer. Initiate DE alarms prior to the fourth periodic automatic report. Command the system to print alarms on the logging printer list prior to the time the periodic automatic report is to be generated.	6. Verify system prints alarm messages on the logging printer, then prints out the fourth periodic automatic report.

TEST NO: Factory-75 Page 1 of 1
TITLE: CRT Failure
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the ability of the operator to interface with the system via remaining CRT's or printers upon failure of the primary CRT display system.

INITIAL CONDITIONS

1. System is operating in normal mode.
2. The contactor provides commands required to transfer controls.
3. Turn off operator's console.

EVENT	EXPECTED RESULTS
1. Via the printer keyboard, command the system to transfer operator console functions to the printer. Enter an operator command via the printer keyboard.	1. Verify the system responds to the command entry.
2. Turn CRT's on and restore functions to CRT operator's console.	2. Verify CRT operator's console is back in operation.

TEST NO: Factory-76 Page 1 of 1
TITLE: FID Stand-Alone Mode
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the software that performs FID functions and FID resident applications programs using data obtained from the DE and based upon the FID RTC.

INITIAL CONDITIONS

1. The contractor provides a list of applications programs resident to the FID.
2. The contractor provides the default parameters for weekdays and weekends to be stored in the FID. (For example, initiate start-stop times for digital points and temperature setpoints for analog points.)
3. The contractor provides input data and expected output on the applications programs to be tested prior to and after the FID non-communicating mode. (Expected results from applications programs with and without FID - control system or communication are different.)
4. The contractor provides expected results on operational data that will be stored in the FID.
5. Selected points in the DE indicate the status of equipment included in the tests.

EVENT	EXPECTED RESULTS
1. Compare the contractor's list of FID application programs against the required list on the contract documents.	1. Verify the contractor's supplied list matches the list in the contract documents.
2. Initiate operation of each FID resident application programs at the operator's console.	2. System requests input parameters appropriate to the application program. Verify equipment operates in accordance with expected results when FID is in communication with the central system.
3. Initiate a communication failure between the central system and the selected FIDs. Allow stand-alone mode to continue for at least one week day and one weekend of a continuous period.	3. Application programs resident in the FID operate operate in the stand-alone mode. Visually verify simulated equipment operates in accordance with stand-alone application programs.
4. At the end of eight days reinitiate communication between the FID and CCU.	4. Verify equipment operates in accordance with expected results when FID is in communication with the central system.

TEST NO: Factory-77 Page 1 of 1
TITLE: FID Stand-Alone Demand Limiting Function
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the stand-alone software that implements a load-rolling sequence at each FID including associated MUX* and IMUX panels in the FID non-communitation mode and with the CCU/CCC** out of service.

INITIAL CONDITIONS

1. The contractor provides a sequence of load control for the demand control programs initiated at the CCU and for the stand-alone demand control program to be executed under a communication failure between the FID and CCU/CCC**. The sequences of control should be different between the two programs.
2. System is set up for electric demand to exceed the maximum allowed demand during the test period.
3. Selected points in the DE represent status of equipment used in the test.

EVENT	EXPECTED RESULTS
1. Initiate conditions causing the system to execute the demand limiting program. Enter command to display equipment status.	1. Verify system display of equipment corresponds to expected results.
2. Initiate a communication failure between the FID and CCU/CCC**.	2. FID resident demand limiting function controls equipment. Visually verify equipment status corresponds to expected results of FID stand-alone demand limiting function with a communication failure between FID and CCU/CCC**.

* Large/Medium EMCS
**Large EMCS

TEST NO: Factory-78 Page 1 of 1
TITLE: FID/MUX/IMUX Failure Mode
APPLIES TO: Large, Medium & Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the performance of the software that forces all FID/MUX*/IMUX outputs to a predetermined state, consistant with the failure modes defined in the I/O summary tables and the control device interfacing with the DE.

INITIAL CONDITIONS

1. The contractor provides I/O summary tables with defined failure modes to match contract requirements.
2. The on line status of I/O points is different from failure mode status.

EVENT	EXPECTED RESULTS
1. Place FID/MUX*/IMUX in failure mode using output disable switch.	1. Verify FID/MUX*/IMUX outputs go into failure mode as defined in the I/O summary table.
2. Remove power to the FID/MUX*/IMUX without battery backup.	2. Verify FID/MUX*/IMUX outputs go into failure mode as defined in the I/O summary table.

*Large/Medium EMCS

TEST NO: Factory-79 Page 1 of 1
TITLE: Error Detection and Retransmission
APPLIES TO: Large EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate error detection and retransmission capabilities between the FID and CCC. This test also verifies CCC shutdown when retransmission attempts exceed an operator assigned maximum.

INITIAL CONDITIONS

1. Maximum number of transmission errors are assigned for each of the DTM.

TEST EQUIPMENT

1. White noise generator on communication error generator.

EVENT	EXPECTED RESULTS
1. Generate and superimpose a white noise or communication error on each DTM.	1. CCC closes down transmission on DTM originating errors and prints an alarm message after the maximum number of transmission errors are reached.
2. Attempt to reopen closed down communications after white noise generator or communication error generator has been removed.	2. CCC reopens communications on shutdown of DTM.
3. Initiate report summary of detected data transmission errors.	3. System displays data transmission error count report.

TEST NO: Factory-80 Page 1 of 1
TITLE: Error Detection and Retransmission
APPLIES TO: Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate error detection and retransmission capabilities between the FID and CCU.

INITIAL CONDITIONS

1. A maximum number of transmission errors are assigned for each of the DTM.

TEST EQUIPMENT

1. White noise generator or communication error generator.

EVENT	EXPECTED RESULTS
1. Generate and superimpose a white noise or communication error on each DTM.	1. CCU closes down transmission on DTM originating errors and prints an alarm message after the maximum number of transmission errors are reached.
2. Attempt to reopen closed down communications after white noise generator or communication error generator.	2. CCU reopens communications to the shutdown device or DTM.
3. Initiate report summary of detected data transmission errors.	3. System displays data transmission error count report.

TEST NO: Factory-81 Page 1 of 1
TITLE: CLT and DTM Failure
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify that no more than ___ percent of the DE points are lost during any DTM failure to the CLT or a DTM failure between CLT and CCU/CCC**.

EVENT	EXPECTED RESULTS
1. Initiate failure of each DTM between DE and CLT, one at a time. Enter command to display FIDs not responding.	1. System displays status for FIDs not responding, which represents less than ___ percent of all points.
2. Initiate DE alarms in the DTM's in service.	2. Verify system displays alarms.
3. Initiate a failure of each DTM one at a time between CLT and CCU/CCC**. Enter command to display FIDs not responding.	3. System displays status for all but ___ percent of DE points.
4. Initiate DE alarm in the DTM's in service.	4. Verify system displays alarms.

**Large EMCS

TEST NO: Factory-82 Page 1 of 2
TITLE: System Power Failure/Automatic Restart
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate CCU/CCC** response to power failures less than or equal to five minutes, from over 5 minutes to 30 minutes, and exceeding 30 minutes.

INITIAL CONDITIONS

1. Selected I/O points are set up to change status during the test.
2. The contractor provides I/O summary tables for each type of analog and digital point used in the test. The I/O summary table identifies the failure mode for each point such that the failure mode is easily distinguished from normal mode.

EVENT	EXPECTED RESULTS
1. Enter command to display status of selected I/O points.	1. System displays I/O status.
2. Initiate a power failure of CCU/CCC** for less than five minutes.	2. System initiates an orderly shutdown of CCU/CCC** and peripherals.
3. Restore power to CCU/CCC** within five minutes.	3. The system automatically obtains the current time-of-day from RTC and performs an automatic restart of CCU/CCC** operation without human intervention.
4. Enter command for display of the previously selected I/O status.	4. System displays I/O status which corresponds with I/O status prior to power failure.
5. Initiate a power failure for greater than 5 minutes but less than 30 minutes.	5. The system initiates an orderly shutdown of CCU/CCC** and peripherals.
6. Change status of selected I/O points that will cause alarm status.	6. There is no system response.

**Large EMCS

TEST NO: Factory-82 Page 2 of 2
TITLE: System Power Failure/Automatic Restart
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate CCU/CCC** response to power failures less than or equal to five minutes, from over 5 minutes to 30 minutes, and exceeding 30 minutes.

EVENT	EXPECTED RESULTS
7. Restore power within 30 minutes from power failure.	7. The system automatically obtains the current time-of-day from RTC and performs an automatic restart of central programs without human intervention. The data base is automatically updated and alarms initiated the DE during the power failure are reported.
8. Initiate a power failure to the system (CCU/CCC**, and FID) in excess of the FID CCU/CCC** memory and RTC battery backup capacity.	8. System initiates an orderly shutdown of CCU/CCC** and peripherals without loss of contents of memory, registers, or machine status. Verify FID/MUX*/IMUX outputs go into failure modes as defined in the I/O summary tables.
9. Restore all power.	9. Equipment is ready.
10. Perform system startup using procedures specified by the computer manufacturer.	10. The system in manually reinitialized before the EMCS functions are restarted. The entire system is placed in operation within one hour. Visually verify resumption of normal mode operation.

**Large EMCS

TEST NO: Factory-83 Page 1 of 1
TITLE: CCU/CCC** Diagnostics
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate capability of the diagnostic programs to detect hardware and software problems at the CCU/CCC** and peripherals and display the corresponding error messages.

EVENT	EXPECTED RESULTS
1. Initiate diagnostic program at the central system (CCU-CCC**) to test software as designated in the contract documents	1. System initiates diagnostic programs and displays the status of each diagnostic routine performed.
2. Initiate diagnostic program for each peripheral device as designated in the contract.	2. System displays status for each diagnostic routine performed.

**Large EMCS

TEST NO: Factory-84 Page 1 of 1
TITLE: FID PROM Programmer
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To demonstrate the capability of the system to store machine language code programs generated in the CCU for execution in a Fid non-volatile memory.

INITIAL CONDITIONS

1. The contractor provides the name and location of the FID programs stored on disk.
2. The contractor provides necessary input required for modification of the PROM program.

EVENT	EXPECTED RESULTS
1. Command the system to list, from the disk file, selected blocks of FID executable code.	1. System displays the contents of the disk file in blocks.
2. Command the system to transfer FID executable code from the disk system to the PROM.	2. System executes command.
3. Command the system to list the contents of the PROM.	3. System lists contents, which must match disk file contents.
4. Enter program modifications.	4. System acknowledges input.
5. Command the system to display revised program contents.	5. System displays contents of the PROM programmer including the specified modifications(s). Verify PROM modification has taken place.
6. Enter command to program PROM.	6. PROM Programmer burns in the PROM program.
7. Enter command to display listing in the programmed PROM.	7. Verify listing of program matches contents of disk based program with exception to modifications entered via event (4).

TEST NO: Factory-85 Page 1 of 2
TITLE: FID Portable Diagnostic Device
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: Demonstrate the capability of the device to perform diagnostics and to debug and exercise all points in FID/MUX*/IMUX.

INITIAL CONDITIONS

1. The contractor provides the set of commands and inputs required to execute the test, including:

   . Listing of operator alphanumeric and decimal interface with diagnostic device.
   . Expected output from FID/MUX*/IMUX diagnostics.
   . Listing of a program that is not PROM-ROM resident in the FID, plus the input and predicted output.
   . Analog/digital point identification (with known values). Select points such that input for point control requires alphanumeric and decimal operation interface.
   . Display of a specific memory location.
   . Input for modification of a specific RAM location.

2. The FID diagnostic device is connected to the FID/MUX*/IMUX.

3. FID/MUX/IMUX are set up to contain known diagnosable errors.

EVENT	EXPECTED RESULTS
1. Run FID diagnostics.	1. Verify system displayed results of diagnostics agree with the predicted results.
*2. Run MUX diagnostics.	2. Verify system displayed results of diagnostics agree with the predicted results.
3. Run IMUX diagnostics.	3. Verify system displayed results of diagnostics agree with the predicted results.
4. Command the system to display the contents of a specific memory location.	4. Verify system displayed results of diagnostics agree with the predicted results.

*Large/Medium EMCS

TEST NO: Factory-85 Page 2 of 2
TITLE: FID Portable Diagnostic Device
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: The FID portable diagnostic programming and bulk loading device test is designed to demonstrate the capability of the device to perform diagnostics and to debug and exercise all points in FID/MUX*/IMUX.

EVENT	EXPECTED RESULTS
5. Enter command to bulk load selected programs into FID/RAM memory. Command the system to display specified FID/RAM memory location which contains a selected program. Command the system to display program listing in the specified memory location.	5. Verify displayed contents contain the selected program(s) and that program listing matches contractor supplied program listing.
6. Enter command to single step FID program execution and display results.	6. Command is executed. Verify output corresponds with predicted results.
7. Enter command to display FID/MUX*/IMUX digital and analog inputs.	7. Verify displayed status of analog and digital input corresponds with predicted results.
8. Enter command to control FID/MUX*/IMUX analog and digital outputs.	8. Analog and digital commands are executed. Verify status of analog and digital outputs match the DE status.
9. Enter command to modify specific RAM location.	9. System enters modification.
10. Enter command to display the contents of modified RAM location.	10. Verify displayed contents of RAM include the modification.

*Large/Medium EMCS

TEST NO: Factory-86 Page 1 of 1
TITLE: FID Test Set
APPLIES TO: Large and Medium EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify the capabilities of the FID and associated DE simulator.

INITIAL CONDITIONS

1. The FID test set is connected via MODEM in the CLT to the CCU (CCC**) in the MCR. DE simulator input and outputs are part of the system data base.

EVENT	EXPECTED RESULTS
1. Exercise the Digital Output (DO) command from the operator's console.	1. DE simulator displays the DO signal received.
2. Exercise Analog Output (AO) from the operator's console.	2. DE simulator displays the AO signal received.
3. Exercise the Digital Input (DI) from the FID test set.	3. Change of status is displayed at operator's console.
4. Exercise Analog Input (AI) from the FID test set.	4. Change of status is displayed at operator's console.
5. Exercise pulse accumulator input from the FID test set.	5. Change of value is displayed at operator's console.
6. Execute in the FID test a FID resident application program.	6. Verify output of program executed at FID test set matches output of program executed at FID.

**Large EMCS

TEST NO: Factory-87 Page 1 of 1
TITLE: Final System Equipment Verification
APPLIES TO: Large, Medium and Small EMCS
REFERENCE: Proj. Spec. Paragraph _____

OBJECTIVE: To verify that the hardware components of the system provided by the contractor are in accordance with the contract plans and specifications and all approved submittals after all tests are completed.

INITIAL CONDITIONS

1. The contractor provides a list of approved system hardware components, including the name of the component, manufacturer, and model number. This list is based on the contract plans, specifications, change orders (if any) and approved submittals which must be available for reference purposes during the test.

EVENT	EXPECTED RESULTS
1. The model numbers of each hardware component should be examined and checked against the model numbers of the equipment provided by the contractor.	1. Model numbers of equipment provided shall match the model numbers of approved equipment on the approved submittals.

APPENDIX A

ABBREVIATIONS

AA	Analog alarm
ac	Alternating current
A/D	Analog to digital
AHU	Air handling unit
AI	Analog input
AO	Analog output
ASCII	American Standard Code For Information Interchange
ATC	Automatic temperature control
B/C	Benefit to cost ratio
bps	Bits per second
Btu	British thermal unit
CCC	Central communications controller
CCU	Central control unit
CHW	Chilled water
CLM	Command line mnemonic
CLMI	Command line mnemonic interpreter
CLT	Communications link termination
CPA	Control point adjustment
cps	Characters per second
CPU	Central processing unit
CRT	Cathode ray tube

CT	Current transformer
D/A	Digital to analog
dB	Decibel
dc	Direct current
DDC	Direct digital control
DE	Data environment
DI	Digital input
DMA	Direct memory access
DO	Digital output
DPS	Differential pressure switch
DTC	Data terminal cabinet
DTM	Data transmission media
DX	Direct expansion
E/C	Energy to cost ratio
EMCS	Energy monitoring and control system
EMI	Electromagnetic interference
EEPROM	Electronically erasable PROM
EPROM	Erasable PROM
FCB	Failover control board
FID	Field interface device
FS	Flow switch
FSK	Frequency shift keying
H/C	Hot/cold
HOA	Hand-off-automatic

HVAC	Heating, ventilating, and air conditioning
HW	Hot water
IC	Integrated circuit
I/O	Input/output
kHz	Kilohertz
kW	Kilowatt
kWh	Kilowatt-hour
lpm	Lines per minute
LSI	Large scale integration
mA	Milliamp
Mb	Megabyte
MBtu	Btu (millions)
MCR	Master control room
MHz	Megahertz
MODEM	Modulator/demodulator
MUX	Multiplexer
OA	Outside air
PROM	Programmable ROM
PS	Pressure switch
psi	Pounds per square inch
psia	Pounds per square inch, absolute
psid	Pounds per square inch, differential
psig	Pounds per square inch, gauge
PT	Potential transformer

RAM	Random access memory
RF	Radio frequency
RFI	Radio frequency interference
RH	Relative humidity
RHT	Reheat
ROM	Read only memory
RT	Run time
RTC	Real time clock
RTD	Resistance temperature detector
SCR	Silicon controlled rectifier
S/I	Simple savings to investment ratio
SIR	Discounted savings to investment ratio
S/N	Signal to noise ratio
S/S	Start/stop
TTL	Transistor-transistor logic

APPENDIX B

DEFINITIONS

Algorithm:	A set of well defined rules or procedures for solving a problem or providing an output from a specific set of inputs.
Analog:	A continuously varying signal value temperature, current pressure, etc.)
Analog to Digital Converter:	A circuit or device whose input is information in analog form and whose output is the same information in digital form.
Architecture:	The general organization and structure of hardware and software.
ASCII:	American Standard Code for Information Interchange. An 8-bit coded character set to be used for the general interchange of data among information processing systems, communications systems, process control systems, and associated equipment. Various character/graphic subsets are discussed in FIPS PUB 15.
Assembler:	Utility program which translates assembly language source code into the machine-executable object code.

Assembly language:	A low-level computer language used to program and manage the operations of a computer.
Asynchronous Computer:	An automatic digital computer in which each operation starts as a result of a signal generated by the completion of the previous event or operation, or by the availability of the parts of the computer required by the next event or operation.
Asynchronous Transmission:	Data transmission in which each character contains its own start and stop bits.
Automatic Temperature Control (ATC)	A local loop network of pneumatic or electric/electronic devices which are interconnected to control temperature.
Background Programming:	A feature of computer hardware to provide a means of writing, testing, and debugging a software program on the computer at the same time the computer is performing other "Real Time" programs.
BASIC:	An acronym for Beginners All-Purpose Symbolic Instruction Code, a highlevel, English-like programming language used for general applications.
Baud:	A unit of signalling speed equal to the number of discrete conditions, or signal events, per second.

Bit:	An acronym for binary digit. The smallest unit of information which can be represented. A bit may be in one of two states, represented by the binary digits 0 and 1.
BCD:	Binary Coded Decimal.
Bit Error Rate:	The number of incorrect or erroneous bits divided by the total number (correct plus incorrect) over some stipulated period of time.
Bootstrap:	A technique or device designed to bring a computer into a desired state by means of its own action.
Break Point:	A point in a program where an instruction or other condition enables a programmer to interrupt the running of a program by external intervention or a monitor routine. Used in debugging.
Buffer:	A temporary data storage device used to compensate for a difference in data flow rate or event times, when transmitting data from one device to another.

Bus:	A circuit path (or parallel paths) over which data instructions are transferred to all points in the computer system. Computers have several separate busses: the data, address, and control busses are those of greatest importance.
Byte:	Eight bits.
Call:	A term used to designate the software procedure by which software control is transferred to a callable subroutine.
Callable:	A subroutine module to which software control can be transferred.
Cathode Ray Tube (CRT):	An electron beam tube in which the beam is focused to a small cross section on a luminescent screen and varied in position and intensity to produce a visible pattern.
Central Memory:	Core or semiconductor memory which communicates directly with a CPU.
Central Communication Controller (CCC):	A computer that performs data gathering and dissemination from and to the FIDs, as well as providing limited backup to the CCU.
Central Processing Unit (CPU):	The portion of a computer that performs the interpretation and execution of instructions. It does not include memory or I/O.

Central Control Unit (CCU):	A process control digital computer that includes a CPU, central memory, and I/O bus.
Character:	One of a set of elementary symbols which normally include both alpha and numeric codes plus punctuation marks and any other symbol which may be read, stored, or written.
Communications Link Terminations (CLT):	An independent piece of hardware that provides an interface point between the CCC and/or CCU and the Data Transmission Links.
Clock:	A device or a part of a device that generates all the timing pulses for the coordination of a digital system. System clocks usually generate two or more clock phases. Each phase is a separate, square wave pulse train output.
Command Line Mnemonic (CLM):	A computer language consisting of a set of fixed, simplified English commands designed to assist operators unfamiliar with computer technology in operating the EMCS.
Command Line Mnemonic Interpreter (CLMI):	Software used to implement the CLM language.

Compiler:	A language translator which converts source statements written in a high level language into multiple machine instructions. A compiler translates the entire program before it is executed.
Controls:	Devices which govern the performance of a system.
Control Point Adjustment (CPA):	The procedure of changing the operating point of a local loop controller from a remote location.
Control Sequence:	Equipment operating order established upon a correlated set of data environment conditions.
Core Resident:	Core resident specifies a program which currently resides in central memory (and may thus be considered active) as opposed to programs residing on the disk which must be loaded into central central memory for execution.
Crowbar:	An electronic circuit which can rapidly sense an over voltage condition and provide a solidstate low impedance path to eliminate this transient condition.
Cycle Time:	In microseconds/word for central memory is the minimum time interval that must elapse between the starts of two successive accesses to any one storage location.

Data Communications Equipment:	A device for transmitting digital information to and from any other system.
Data Environment (DE):	The sensors and control devices connected to a single FID/MUX/IMUX (IMUX only in small and micro systems) from the equipment and systems sampled or controlled.
Data Terminal Cabinet (DTC):	An independent metallic enclosure that provides an interface point between the FID/MUX/IMUX Field Wiring Terminals and the Data Environment.
dbm:	A measure of absolute power values. Zero dbm equals one milliwatt.
Data Transmission Media (DTM):	Transmission equipment including cables and interface modules (excluding MODEMs) permitting transmission of digital and analog information.
Debug:	The procedure of running a program to detect and correct errors in a program.
Decibel (db):	The standard unit for expressing transmission gain or loss utilizing logrithmic power and voltage ratios.
Deck:	In HVAC terminology, the air discharge of the hot or cold coil in a duct serving a conditioned space.

Demand:	The term used to describe the maximum rate of use of electrical energy averaged over a specific interval of time and usually expressed in kilowatts.
Demultiplexer:	A device used to separate two or more signals previously combined by compatible multiplexer for transmission over a single circuit.
Diagnostic Program:	Machine-executable instructions used to detect and isolate malfunctions.
Digital Signals:	A discontinuous signal, the various states of which are descrete intervals apart. In some systems, the signal is either on or off (zero or one) and is referred to as binary.
Direct Digital Control (DDC):	Sensing and control of processes directly with digital control electronics.
Digital to Analog (D/A) Converter:	A hardware device which converts a digital signal into a voltage or current proportional to the digital input.
Direct Memory Access (DMA):	Provision for transfer of data blocks directly between central memory and an external device interface.

Disk Storage:	A bulk storage, random access device for storing digital information. Usually constructed of a thin rotating circular plate having a magnetizable coating, a read/write head and associated control equipment.
Distributed Processing System:	A system of multiple processors each performing its own task, yet working together as a complete system under the supervision of a central computer, to perform multiple associated tasks.
Download:	The transfer of digital data or programs from a host computer to another data processing system such as central computer to microcomputer.
Driver/Handler:	Software which manages input/output to and from a given peripheral device.
Duplex:	A method of operation of a communications line in which each terminal can simultaneously transmit and receive.
EMCS:	Energy Monitoring and Control System.
Executive Program:	The main system program designed to establish priorities and to process and control other programs.

Failover Controller: A hardware device or software to transfer the communications function from CCU to CCC in the event of CCU failure, or the communications functions from CCC to CCU in the event of CCC failure.

Fall-Back Mode: The pre-selected operating mode of a FID when communications cease with the MCR or the operating sequence of each local control loop when the FID to which it is connected ceases to function.

Field Interface Device (FID): A small, intelligent hardware device containing software which implements the distributed processing aspects of operation with the central computer as well as maintaining effective control of field control loops in the absence of higher level influence. Operating constants are changed by down-line loading from the CCC as well as from within the FID.

Firmware: A procedure for accomplishing arithmetic operations where the instruction set is resident in ROM or PROM.

FORTRAN:	An acronym for FORmula TRANslation. A highlevel, English-like programming language used for technical applications.
Function Keys:	Keys which, when depressed, send more than one character and are interpreted by the computer as a specific command.
Half duplex:	A method of operation of a communications line in which each terminal can transmit and receive, but not simultaneously.
Hardware:	Equipment such as a CPU, memory, peripherals, sensors, and relays.
Hardware Vectored Interrupts:	Hardware feature which allows the CPU to directly determine the identity of an interrupting device and to automatically transfer control to a program which will service the interrupt.
Initialization: (of the System)	The process of loading the operating system with the computer. Initialization is required to start normal operation of the computer after the computer has been out of service.
Intelligent Multiplexer (IMUX):	A device that combines data from a number of points in the DE and communicates on a single channel in the "report by exception" mode.

Input/Output Bus:	The connection through which data is transmitted and received from peripheral devices interacting with the processor.
Input/Output (I/O) Device:	Digital hardware that transmits or receives data.
Interactive:	Functions performed by an operator with the machine prompting or otherwise assisting these endeavors, while continuing to perform all other tasks as scheduled.
Interpreter:	A language translator which converts individual source statements into machine instructions by translating and executing each statement as it is encountered.
Interrupt:	An external or internal signal requesting that current operations be suspended to perform more important tasks.
Large Scale Integration (LSI):	The technology of manufacturing integrated circuits capable of performing complex functions. Devices of this class contain 100 or more logic gates of a single chip.

Line Conditioning:	Electronic modification of the characteristic response of a line to meet certain standards. The characteristics include frequency response, signal levels, noise suppression impedance, and time delay.
Line Driver:	A hardware element which enables signals to be directly transmitted over circuits to other devices some distance away.
Loader:	A program used to prepare the computer and store other programs into memory locations in preparation for machine execution.
Local Loop Control:	The controls for any system or subsystem which existed prior to the installation of an EMCS and which will continue to function when the EMCS is non-operative.
Macro:	A single programming symbolic instruction that generates multiple assembly language instructions.
Machine Language:	The binary code corresponding to the instruction set of the CPU.
Master Control Room (MCR):	The central Facility containing the operator console, CCU, CCC, and related equipment for control and supervision of the complete EMCS.

Medium Scale Integration (MSI):	As in LSI but to a lesser degree.
Memory:	Any device that can store logic 1 and logic 0 bits in such a manner that a single bit or group of bits can be accessed and retrieved.
Memory Address:	A binary number that specifies the precise memory location of a stored word.
Memory Modules:	Increments of memory, usually 4K, 8K, 16K, etc. words in length.
Microcomputer:	A computer system based on a microprocessor and containing all the memory and interface hardware necessary to perform calculations and specified transformations.
Microprocessor:	A central processing unit fabricated as one integrated circuit.
Mnemonic:	A symbolic representation or abbreviation to help operators remember and understand.
MODEM:	An acronym for MOdulator/DEModulater. A hardware device used for changing digital information to and from an analog form to allow transmission over voice grade circuits.
Multiplexer MUX:	A device which combines multiple signals on one transmission media.

Multi-Tasking: The procedure allowing a computer to perform a number of programs simultaneously under the management of the operating system.

Non-Volatile Memory: Memory which retains information in the absence of applied power (i.e.; magnetic core, ROM, and PROM).

Normal Mode Operation: Equipment operating and performing its assigned tasks.

Object Code: A term used to describe machine language.

Operating System: A complex software system which manages the computer and its components and allows for human interaction.

Optical Isolation: Electrical isolation of a portion of an electronic circuit by using optical semiconductors and modulated light to carry the signal.

Parameter: A variable that is given a constant value for a specific purpose or process.

Parity: A checking code within a binary word used to help identify errors.

PASCAL: A "structured programming" high level computer language.

Peripheral Equipment: Equipment used for man-machine communications and further support of a processor.

Point:	Individual connected monitor or control devices (i.e., relay, temperature sensor).
Prediction Program:	Applications software which allows continuous prediction of a future value and subsequent correction based on actual measurements.
Process Automation:	Process control without human intervention.
Process Control:	The collective functions performed by the equipment which is to control a variable.
Program:	A sequence of instructions causing the computer to perform a specified function.
Prompt/Response Sequence:	Man-Machine dialogue by which the computer asks questions and requests responses from the operator.
Protocol:	A formal set of conventions governing the format and relative timing of message exchange between two terminals.
Random Access Memory (RAM):	Volatile semiconductor data storage device in device in which data may be stored or retrieved. Access time is effectively independent of data location.
ROM, PROM, EPROM, EEPROM:	Read-Only-Memory, Programmable ROM, Erasable PROM, Electronically Erasable PROM. All are non-volatile semiconductor memory.

Real Time:	A situation in which a computer monitors, evaluates, reaches decisions, and effects controls within the response time of the fastest phenomenon.
Real Time Clock (RTC):	A device which indicates actual time of day. The RTC may be updated by hardware or software.
Register:	A digital device capable of retaining information.
Reinitialization:	Refer to initialization.
Resistance Temperature Detector (RTD):	A device where resistance changes linear as a function of temperature.
RTDOS/E:	Real-Time Disk Operating System/Executive.
Selective Generation:	Where the management of input/output is restricted to selected peripherals.
Sensors:	Devices used to detect or measure physical phenomena.
Single Stepping:	Procedure by which the next statement in a core resident program is executed by depressing a switch.
Snapshot:	Picture of the instantaneous status and state of a system.
Software:	A term used to describe all programs whether in machine, assembly, or high-level language.

Source code: A term used to describe assembler and high level programmer developed code.

Stand-Alone: A term used to designate a device or system which can perform its function totally independent of any other device or system.

Supervisory Control: Separate (and usually remote) control and monitoring of local control loops. (See Direct Digital Control.)

System Normal Heavy Load Conditions: System normal heavy load conditions are defined as the occurrence throughout the system of a total of three status changes, three digital alarms, three analog high or low limit alarms, and three analog quantity changes within the high and low limits during a single one second interval. This number of similar occurrences shall repeat on a continuous basis during successive 1 second intervals for up to 30 seconds. The system normal heavy load conditions shall have 50 percent of the changes and alarms, including no less than one of each type, occurring at a single FID, MUX, or IMUX with the remaining changes and alarms distributed among the remaining FID/MUX/IMUXs.

	No DTM link shall be more than 65 percent loaded during this normal heavy load condition and the alarm printer shall continue to print out all occurrences.
Throughput:	The total capability of equipment to process or transmit data during a specified time period.
Time Base Generator (TBG):	See Clock
Time Tag:	Date and time of occurrence of an event.
True digital:	A representation of any value by symetric digits, used to form fixed length words.
Volatile Memory:	A semiconductor device in which the stored digital data is lost when power is removed.
Word:	A set of binary bits handled by the computer as the primary unit of information.
Zone:	An area composed of a building, a portion of a building, or a group of buildings affected by a single device or piece of equipment.

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ARMY ENG DIV EUDED-TM (O'Malley),; HNDED-ME (Carlen), Huntsville, AL; HNDED-ME (DeShazo), Huntsville, AL; HNDED-ME (Herden), Hunstville, AL; HNDED-ME (Holland), Huntsville, AL; HNDED-ME (Wilcox), Huntsville, AL; HNDED-PM (Brown), Huntsville, AL; HNDED-PM (Ganus), Huntsville, AL; MRDED-TM (Beranck), Omaha, NE; MRDED-TM (Jones), Omaha, NE; NADCO-CM (Eng), New York, NY; NADEN-TM (Stuart), New York, NY; NPDEN-TE (Wottlin), Portland, OR; ORDED-T, (Norman), Cincinnati, OH; PODED-T (Nakasone), Ft. Shafter, HI; SADCO-CC (Mindel), Atlanta, GA; SADEN-TE (Smith), Atlanta, GA; SPDED-TG (Kishaba) San Francisco, CA; SWDED-M (Powell), Dallas, TX

ARMY ENGR DIST. CO, Tulsa, OK; MRKED-DM (Rabuse), Kansas City, MO; MRKED-M (McCollum), Kansas City, MO; MROCD-SM (Hall), Omaha, NE; MROCD-SM (O'Brien), Omaha, NE; MROED-DC (Sawick), Omaha, NE; NABCO-S (Meisel), Baltimore, MD; NABEN-D (Kelly), Baltimore, MD; NANCO-C (Spector), New York, NY; NANEN-DM (Kessenides), New York, NY; NAOEN-MA (Daughety), Norfolk, VA; NAOOP-C (Herndon), Norfolk, VA; NPSEN-DB (Eason), Seattle, WA; ORLED-D (Pfeifer), Louisville, KY; SAMCO-SI (Rawls) Mobile, AL; SAMEN-C (Anderson), Mobile, AL; SAMEN-CI (Tunnell), Mobile, AL; SASEN-DF (Plunkett), Savannah, GA; SASEN-MA (Grimes), Savannah, GA; SCD-SB (Stone), Savannah, GA; SPKCO-C (Del Porto), Sacramento, CA; SPKCO-C (Evans), Sacramento, CA; SPKED-M (Lowell), Sacramento, CA; SPKED-M (Stoner), Sacramento, CA; SPLCO-CS (Molina), Los Angeles, CA; SWFCD-ST (Ready), Ft. Worth, TX; SWFCD-ST (Wood), Ft. Worth, TX; SWFED-DM (Story), Ft. Worth, TX; SWFED-DM (Wike), Ft. Worth, TX

NAVFACENGCOM Code 03 Alexandria, VA; Code 03T (Essoglou) Alexandria, VA; Code 04 Alexandria VA; Code 04T2 (Knapp), Alexandria, VA; Code 04T2B (McGrath), Alexandria, VA; Code 04T7B (Stickley), Alexandria, VA; Code 05D1 (Bersson), Alexandria, VA; Code 09M54, Technical Library, Alexandria, VA; Code 111 (Mitchum), Alexandria, VA; Code 1112E (Tayler), Alexandria, VA; Code 111B (Hanneman), Alexandria, VA

NAVFACENGCOM - CHES DIV. CO, Washington DC

NAVFACENGCOM - ~~LANT~~ DIV. Norfolk, VA

NAVFACENGCOM - NORTH DIV. CO

NAVFACENGCOM - PAC DIV. Commander, Pearl Harbor, HI

NAVFACENGCOM - SOUTH DIV. CO, Charleston SC

NAVFACENGCOM - WEST DIV. San Bruno, CA

NAVFACENGCOM CONTRACTS OICC, Kings Bay, GA

NAVSHIPYD PWO, Mare Is.

USAF AFRCE/CR ~~(Walton)~~, ~~Dallas, TX;~~ AFRCE/ER (Burns), Atlanta, GA; AFRCE/M-X (Stevens), Norton AFB, CA; AFRCE/WR (Lowry), San Francisco, CA

USAFE HQ DEE (EMCS Mgr), Ramstein AFB, Germany

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